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**Laboratory exercises and methods
in secondary agriculture**

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LABORATORY EXERCISES AND METHODS
IN SECONDARY AGRICULTURE

BY

GARLAND ARMOR BRICKER

B. Ped., Lima College, 1907

THESIS

Submitted in Partial Fulfillment of the Requirements for the

Degree of

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IN

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

===== GARLAND ARMOR BRICKER =====

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IN SECONDARY AGRICULTURE

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MASTER OF ARTS.

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LABORATORY EXERCISES AND METHODS

IN SECONDARY AGRICULTURE.

INTRODUCTION.

Agriculture as a subject for secondary schools is just now in the experimental stage in this country.* Seventeen years ago it was not included in the Report of the Committee of Ten of the National Education Association, which was appointed to make an investigation of secondary school studies.° There is little agreement among school men and agriculturists as to what portions of this great subject should be taught in the secondary school, and to what degree of completeness such portions should be carried. This unsettled condition is nowhere better shown than in the material contained in the recent secondary text-books of agriculture that have appeared and the plan pursued by the several authors in

* True, Dr. A. C.: "Progress in Secondary Education in Agriculture." Yearbook, Department of Agriculture, 1902, pp. 481-500.

° Report of the Committee of Ten of the National Education Association on Secondary School Studies, 1893.

the development of the subject.⁺ Another evidence of this chaotic state in which secondary agriculture at present exists is the fact that few colleges and universities have yet been able to define what shall constitute a unit in this subject toward satisfying their entrance requirements.

So far as our knowledge goes, we do not know of a single book that treats of the methods of teaching this subject in the high school. A considerable amount has been written on the methods of teaching nature-study in the elementary school.^x The

+ Following is a list of the best recent texts on general agriculture intended for secondary schools that we have examined:
Bailey, L. H.: "The Principles of Agriculture." Macmillan, New York, 1907. pp. 300.

Brooks, William P.: "Agriculture." Three volumes. The Home Correspondence School, Springfield, Mass., 1903.

Goodrich, Charles L.: "The First Book of Farming." Doubleday, Page and Co., New York, 1905. pp. 259.

Jackson, C. R. and Daugherty, Mrs. L. S.: "Agriculture through the Laboratory and School Garden." Orange Judd, New York, 1908. pp. 450.

Voorhees, Edward B.: "First Principles of Agriculture." Silver, Burdett, Boston, 1896. pp. 212.

Warren, G. F.: "Elements of Agriculture." Second edition. Macmillan, New York, 1910. pp. 434.

For the High School and Grammar Grades.

Burkett, C. W.; Stephens, F. L., and Hill, D. H.: "Agriculture for Beginners." Ginn, Boston, 1904. pp. 339.

Davis, Charles W.: "Rural School Agriculture." Orange Judd, New York, 1907. pp. 267.

Goff, Emmet S. and Mayne, D. D.: "First Principles of Agriculture." American Book Co., Cincinnati, 1904. pp. 256.

Hatch, K. L. and Haselwood, J. A.: "Elementary Agriculture with Practical Arithmetic." Row, Peterson, Chicago, 1907. pp. 198.

Ivins, Lester S.: "Agriculture in the Public Schools." March Bros., Lebanon, Ohio, 1909. pp. 156.

James, Charles C.: "Practical Agriculture." Appleton, New York, 1906. pp. 203.

Soule, Andrew M., and Turpin, Edna Henry Lee: "Agriculture, Its Fundamental Principles." Johnson Pub. Co., Richmond, 1907. pp. 320.

x Following are the best recent books that have been published on nature-study and methods:

agricultural colleges have their own peculiar methods adaptable to the needs of the college student. The field embracing secondary school methods in agriculture is still a virgin field.

The methods that seem to be invading the high schools with the subject come from three distinct sources. The teachers who have taught nature-study in the grades, and who are now entering the high school to teach agriculture, are bringing with them and applying the methods which they formerly used with mere children. The agricultural college graduate brings with him an excellent knowledge of the subject, but his knowledge of methods of teaching it is meager, and what he has learned from his college experience is poorly adapted to high school pupils. The high school science teacher too often views this subject unsympathetically, and when he undertakes its instruction insists upon applying methods which he is in the habit of using with pure science, whereas agriculture must be taught both as a science and an art.

So long as secondary agriculture remains unsatisfactorily defined, there will be no harmony of agreement with respect to what shall be taught; so long as no definite principles of procedure are enunciated and established, the subject will remain unsystematized; and until we fully recognize agriculture as both a science and an art, we will go amiss in developing proper methods for its instruction. It is in these three directions that the problems of this thesis lie.

Bailey, L. H.: "The Nature Study Idea." Doubleday, Page and Co., New York, 1903.

Hodge, Clifton F.: "Nature Study and Life." Ginn, Boston, 1902.

Howe, Edward Gardnier: "Systematic Science Teaching." Appleton, New York, 1895.

Jackman, Wilbur S.: "Nature Study for Grammar Grades." Macmillan, New York, 1899.

FIRST PART.
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CHAPTER I.
=====

THE NATURE OF SECONDARY AGRICULTURE.
=====

The present unsettled status of secondary agriculture* will not admit of a concise and specific definition. The trend of development is such, however, that we may in a general way define its boundaries and lay down fundamental principles as to what it should be, both in content and extent. Our first duty will be to locate it in the general scheme of agricultural education.

1. Elementary Agriculture.

Similar to the more popular sciences such as botany, physics, physiology, and chemistry, agriculture has its common, every-day, elementary facts with which every one in country and village should be more or less acquainted. Such facts are, the proper time for planting seeds and for harvesting crops, the appearance of the various seeds, fruits, and plants at their various stages of development, the different kinds of soils, the use of manure, the structure and use of the common tools used on the farm and in the garden, the phenomena of the souring of milk, the ripening of cream, the churning of butter, and a thousand-and-one other things common to ordinary farm life. Most of these elemental facts depend upon

* Jewell, James Ralph: "Agricultural Education Including Nature Study and School Gardens." Bureau of Education, Bulletin No. 2, 1907. p. 78. Chapter IV. begins with a brief comparative study of secondary agricultural education in other countries.

the observational faculty of the individual for their acquirement. An acquaintance with these things requires no previous knowledge of deep-lying and fundamental principles. Most country children know them and love them. What child has not opened its heart to the sweet influence of the dandelion blossoms, to the rippling of the brooks, and to the delightful odor of the new mown hay? The martial spirit of the younger boys of the farm finds (too often) an expression in many a hard fought battle with the bumblebee. The hard frozen soil, the washing effects of the streams, the endless sprouting of troublesome weeds, the one abandoned and unproductive spot on the farm that was allowed to him from which to make a fortune-- these are some of the difficulties that most country boys have met in the course of their preadolescent life.

The foregoing will suggest a field for the work in elementary agriculture, or agricultural nature study, in the elementary school.^o The object at this stage should be to get a wide, intelligent, and sympathetic acquaintance with the more evident things of nature and man's relation to them. Correct ideas should be gained of environmental materials.⁺ Such an experience and knowledge of the more common things regarding plants, animals, and soils and other conditions of food production should be gained so as to form a practical working basis for future instruction in the more abstract scientific principles of agriculture. It matters

^o "The Agricultural Phase of Nature-Study," Chapter VII. of Bailey's "The Nature-Study Idea." See especially p. 67.

⁺ Bailey, "The Nature-Study Idea." Chap. I., "What Is Nature-Study?" pp. 4, 65.

Scott, Charles B.: "Nature Study and the Child." Heath, Boston, 1900. "What Is Nature Study?" Chapter III., pp. 89-101.

"Nature Study for Grades of School Below the High School." "General Principles and Plans." pp. 142-151, N. E. A. Report of the Committee of Ten on Secondary School Studies. 1904.

little whether the child so taught further pursues agricultural studies in the high school or college; the basis which he forms in his early study of nature, will be useful to him thruout life, and will bring many joyful reactions by encouraging further observation and contemplation of natural phenomena.

To this stage belongs the school garden. There is perhaps no other agency thru^{which} the village or city child may get so true and wholesome an experience with nature, and the elementary principles of agriculture. It is absurd to think of taking a class of high school boys to a garden in order to show them the difference in the appearance of emerging bean, tomato, radish, onion, and other seedlings, and yet such simple exercises are sometimes found necessary! All such elementary work should be done in the elementary school.

The work of the elementary school should confine itself to an elementary study of the common things of the farm, field, and forest. The names, uses, striking characteristics, morphology, and habits of the common objects in the physical and the biological worlds, and something of their relative importance to man should be observed, studied, and fixed in the life of the child before he enters the high school.^x "Agriculture, even in the grades, is something more than ordinary nature study. It is nature study plus utility. It is nature study with an economic significance. It is nature study which articulates with the affairs of real men

^x Crosby, D. J.: "Training Courses for Teachers of Agriculture." Yearbook, Department of Agriculture, 1907, pp. 215-6. See also Circular No. 60, Office of Experiment Stations, Department of Agriculture, on "The Teaching of Agriculture in the Rural Common Schools;" and the Report of the N. E. A. Committee on "Industrial Education in Schools for Rural Communities." 1905.

in real life. It is nature study in which the child may influence the process. It is nature study which distinctly stimulates industry."*

2. Collegiate Agriculture.

We have endeavored to show the nature of the work to be done in elementary agriculture. We shall now take a brief view of the agricultural instruction in the college.

At present much of the agricultural instruction in the college is of a secondary character.^o This has been made necessary because the secondary schools have hitherto neglected to give instruction in the subject of agriculture, and the colleges have been compelled to receive their students directly from the elementary or rural schools and prepare them for the real collegiate work. But as the secondary schools begin to take up the work of such instruction in agriculture as they are best qualified to impart, the colleges are gradually raising their entrance requirements, and are discontinuing the strictly secondary work.⁺

The work of the agricultural college should lie in the investigation and study of the more deeply fundamental problems of agricultural science and practice. The work here is highly scientific. "Advanced botany, chemistry, physics, zoology, and entomology, are taught and the science of agriculture is emphasized more than

* Davenport, E.: "Education for Efficiency." Heath, Boston, 1909. p. 139. Chapter VIII. is a discussion of "Agriculture in the Elementary Schools."

^o True, A.C.: "Progress in Secondary Education in Agriculture." Yearbook, Department of Agriculture, 1902, p. 494.

⁺ True, A.C. and Crosby, Dick J.: "The American System of Agricultural Education." Office of Experiment Stations-- Circular 83, p. 12.

the art."^x Just as the aim of the engineering college is to turn out professional engineers who are in effect specialists in their various lines, so the aim of the college of agriculture is to give to the world agricultural specialists. A prominent feature of the work in this institution that stands at the top of the agricultural system is research work for the discovery and application of new facts in the science and the art of agriculture. *

3.Secondary Agriculture.

The work of the secondary school lies between these two extremes. "Before discussing details further, let me say that when I speak of teaching agriculture in our high schools, I mean agriculture. I do not mean nature study, nor do I mean that some sort of pedagogical kink should be given to chemistry or botany or even geography and arithmetic. Let these arts and sciences be taught from their own standpoint, with as direct application to as many affairs of real life as possible; but let chemistry continue to be chemistry, and let agriculture introduce new matter into the schools and with it a new point of view. Nor should this new matter be 'elementary agriculture'. In some ways I could wish the phrase had never been coined. What is wanted in our high schools is not elementary agriculture but elemental, fundamental agriculture. For this purpose we should select out of what is taught in our colleges not only those phases of agriculture which are adapted to use in the high school, but also ^{those} that strike at the root of

x Crosby's "Training Courses for Teachers of Agriculture," p.216.

* Consult "A Four-Year's' College Course in Agriculture." Circular 69, Office of Experiment Stations, Department of Agriculture.

farm life and its affairs-- something that will appeal to real farmers and that will serve actually to educate their boys for the business of farming-- soil physics, soil fertility, laboratory fields in crop production, the use of farm machinery, and the classification and principles of feeding of live stock."^o

In the common, non-technical high school agricultural instruction will involve the knowledge and application of some of the principles of secondary botany, physics, and chemistry. Plant physiology, the ecology of domestic plants, the elements of horticulture, the types, conditions, fertility and cultivation of soils, some of the more important physical and biological agencies in their relations to crop production, the different breeds and types of farm animals, the principles of feeding, the fundamental principles of dairy husbandry, plant diseases and insect pests together with methods of combating them, farm machinery, farm buildings, and farm management together with the keeping of farm records and accounts will form the basis of instruction in secondary agriculture.⁺ In the technical high schools and private secondary schools where a four years' course is offered, the work will be more comprehensive. Greater opportunities for practice can be given and the students graduated from such schools will have a greater skill in connection with the work of the farm and their education will be of a more technical nature.

^o See Davenport's "Education for Efficiency," p. 126. Chapter VII. of this book treats on "Agriculture in the High School," and an "Outline of Four Years' Work in High School Agriculture" is given, beginning on page 128.

⁺ Crosby's "Training Courses for Teachers of Agriculture," p. 216. See also Circular 49, Office of Experiment Stations, Department of Agriculture, entitled, "Secondary Courses in Agriculture."

The laboratory exercises and experimental field work will involve more of the fundamental principles than was possible in the elementary school. There should be experimental plots in connection with the school so that the scientific principles studied may be demonstrated in actual practice. Areas should be had upon which hotbeds and coldframes may be built, and a small greenhouse is indispensable. The student should be encouraged in experimental work at home, and in the reading of the various agricultural bulletins and papers.^x

It will thus be seen that a concise and exact definition of secondary agriculture is scarcely possible at this stage of development. It, however, lies between the agricultural nature-study teaching of the elementary school on the one side and the advanced scientific agricultural instruction and investigation of the college on the other. Secondary agriculture is the study of the elementary scientific principles applicable to farming and farm life-- and practice in such application. Principles that are elementary,^{or} elemental, are not necessarily limited to the elementary school.*

* True's "Progress in Secondary Education in Agriculture," pp. 486-7, Yearbook, Dept. of Ag., 1902.

* Brown, Elmer Ellsworth: "The Making of Our Middle Schools." Longmans, New York, 1903. On pages 1-6 Dr. Brown gives an excellent discussion of the general field of secondary education.

CHAPTER II.

=====

SECONDARY AGRICULTURE SHOULD BE TAUGHT AS A SEPARATE SCIENCE.*

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The past half century has seen the organization and growth of a great scheme of agricultural education. Out of the provisions of the Morrill Act, which became a law July 2, 1862, the means were provided for the higher institutions of collegiate grade. But these institutions, altho they have done admirable work, have not succeeded in meeting the practical needs of the people. This failure, tho perhaps no fault of the institutions themselves, and certainly not attributable to a lack of willingness and energy upon their part, is nevertheless a fact, and this is recognized by both the agricultural colleges and the rural population. These higher institutions of learning are too far removed from the very people for whom they were instituted.

From below, an effort to reach the country people thru nature study in the grades and the country schools cannot be said to have succeeded. It is very evident that the principles of agriculture cannot be successfully taught to pupils under the adolescent age, much less the way pointed out for their intelligent application. The high school alone seems to meet the requirements. This institution lies much closer to the rural population, and its pupils are of an age when they can be taught the more practical scientific

* See EDUCATION Vol. XXX., pp. 352-356, where this article, with the exception of a few minor changes, first appeared.

principles involved in practice. The result is that the high schools are adopting agriculture either as an elective or as a required branch; where institutions of the secondary grade do not already exist, the "agricultural high school" is rising to meet the demands of the farming class.

Just now, with the agitation for securing a recognition of agriculture in the high schools, another problem is confronting secondary school men; namely, the successful teaching of the physical and the biological sciences. Statistics show that there is a falling off in the number of students taking scientific studies.^o The testimony of secondary school men of experience indicates that the teaching of these sciences is not satisfactory, and the college professors who receive the graduates of the secondary schools are notoriously chronic complainers. Of course there are reasons for this state of affairs; but it is not the province of this chapter to discuss them, nor to propose remedies. We are now concerned only with a possible danger to successful secondary agricultural education.

It has been proposed, and is being advocated, that the sciences in the high schools be taught more as applied sciences,⁺ which, thus far, may be well; but it is further urged that the application be made to agriculture. In other words, it is

^o Report of the United States Commissioner of Education for 1907, Vol. II., pp. 1048-52.

⁺ Hall, G. Stanley: "Adolescence: Its Psychology and Its Relation to Physiology, Anthropology, Sociology, Sex, Crime, Religion, and Education." Two volumes. Appleton, New York, 1905. See Vol. II., pp. 153, 156-7.

Giles, F. M.: "Teaching Agriculture in the High School." School Review, 17: 154-65.

proposed to tack the science and practice of agriculture to the various sciences of the high school as a sort of appendage to them.^x It is against this proposal that we raise these words in protest.

A disposition has been apparent on the part of some who have undertaken the explanation of matters agricultural to treat them in a somewhat disconnected and poorly organized manner. They do not allow sufficient prominence to the fact that agriculture is itself a science. The various natural sciences, it is true, shed a glorious light upon the principles of agriculture, but we must be careful to discriminate between them and agriculture itself. There is danger in presenting the subject as tho it were a patchwork or a mosaic composed of fragments of all the known sciences. While the agricultural teacher ought to be well instructed in the various sciences bearing upon agriculture, he ought not to forget that he has chiefly to do with a great central subject upon which other sciences throw their beneficent rays.* "Teaching agriculture is much more than teaching a conglomeration of physical and biological sciences. Educators are coming to see more and more clearly that agriculture is both a science and an art, and as a result, it is being taught in ways which are not strictly applicable to the teaching of the other sciences."^o

× Main, Josiah: "Correlation of High School Science and Agriculture," EDUCATION, XXX. 135-45.

*Wrightson, John: "The Principles of Agricultural Practice as an Instructional Subject." Chapman and Hall, London, 1889. Second edition. pp. 1-2.

° Crosby's "Training Courses for Teachers of Agriculture." Yearbook, Dept. of Ag., 1907, p. 218.

There is even less reason to ask that agriculture be taught in connection with the other sciences of the high school than there is to insist that physical geography or physiology be thus taught. Numerous functions and processes considered in this latter branch can be explained only by demonstrations drawn from other sciences. The processes of digestion are explained by the applications of chemical and physical principles. The relation of the ocular function to light is explained by optics. The several classes of levers by which movement is obtained in the human body are ideas explained by physics. What science does not contribute to physiology as it is today taught in the high school? Botany, likewise, draws upon physics, chemistry, agriculture, bacteriology, and geography, and yet few will advocate correlating it to these related sciences at the expense of a separate place in the curriculum. It is desirable that the boy secure a clear and organized view of agriculture as a science very intimately related to agriculture as an art. This will not follow from a piece-meal teaching of unassociated principles of agriculture. We do not say that application of the principles of the physical and the biological sciences shall never be made to agriculture, but that the applications shall not always be made, whenever possible, to this subject; the principles of these sciences may often be applied in other arts quite as well and with greater regard for the rights of the student.

So close a correlation of agriculture with the other sciences of the high school would necessitate a violation of the democratic principle that needs to be respected in these schools

of the people.⁺ In the schools where agriculture should be taught, at least as an elective branch, will be children who will in later life enter industries quite distinct from agriculture. Some will enter factories, some will become engineers, some will become interested in the mining industry, while others will enter any one of the various pursuits, all of which are modes of life quite as essential in a civilized society as is food production. To give every boy in the high school a bent toward agriculture would be a step as radically wrong as it is uncalled for. Every boy and girl in city and country should be so taught that if he is compelled to drop out of school to-morrow his work up to the close of today's session would be such as to give him the best possible preparation for life. It is not giving a student a "square deal" to hold him so closely to an industrial education of a peculiar kind at this period of life. If agriculture be taught as a separate branch, then those students who do not wish to receive instruction in agriculture will be unhampered by a lot of agricultural material in the pursuit of the other sciences, while the boys who wish to study agriculture may do so without a violation of the rights of others and yet secure all the benefits of a course of instruction which they desire.

Another theory of those who advocate the teaching of agriculture in connection with the other sciences is that if this subject is not so taught it must come after them. This theory is not substantiated by actual test. The writer has successfully taught two high school classes in this subject, when the only

⁺ Carlton, Frank Tracy: "Education and Industrial Evolution." Macmillan, New York, 1908. See especially pp. 7-12, 316.

science work that had preceded was a half year each of physiology and physical geography, and no other science course was taken at the same time. The average high school boy does not care to know the exact "why"; he wants no long, explicit statement of the exact physical causes that compel the water to pass thru the tissue of the root-hairs. He is rightly willing to defer that for a later period of his life. He now wants to see a process that will explain the matter to his own adolescent mind, and then he is ready for the practical application of the fact.^x Men who have been long absorbed in science studies are often unable to see this point. A professor in a college of agriculture once asked the writer, if it was thot advisable to perform an experiment in osmosis befor a class of high school pupils who had never studied the principle in physics!

Agriculture, if taught as a separate science will hold its own as a subject in the high school. Dr. A. C. True has conclusively shown that agriculture may be rightfully considered as a science,* and that it possesses true educational value for the student.^o It is also gratifying to see that a majority of men who have had actual experience in teaching the subject advocate its being taught separately. Out of seventy-two questionnaires sent to both secondary school men and to college professors,

^x Cf. Hall, "Adolescence," Vol. II. pp. 153, 156.

^{*} "The Science of Agriculture." Annual Report of the Office of Experiment Stations, 1902, p. 423.

^o "Educational Values of Courses in Agriculture." Annual Report of the Office of Experiment Stations, 1902, p. 435.

forty-eight "advised that agriculture in the high school be taught as a separate science," while only twenty-four "advised that agriculture should be correlated with other studies." On the other hand, if agriculture should be attached to the other sciences for the purpose of instruction, no one knows how soon the "attachment" would be lopped off, and the teaching of agriculture thus come to an end. Those who advocate its introduction into the high school should not allow their enthusiasm to be so easily satisfied with only a passing recognition. Agricultural illustrations in connection with the various sciences usually taught in the high school will never take the place of the independent subject of agriculture any more than would medical illustrations in connection with college zoology, botany, and chemistry take the place of an independent medical course.

In view of the reasons above presented, it is our conviction that secondary agriculture should be given an independent place by the side of the other secondary school studies.

CHAPTER III.

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THE PSYCHOLOGICAL DETERMINATION OF SEQUENCE.

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The many phases of agriculture that are desirable to have taught the youth, and the apparent chaotic condition of the whole field from the pedagogical point of view, seem to necessitate the statement of some plan of procedure in the presentation of the subject that shall have a sound pedagogical basis. In working out methods for the teaching of any department of human knowledge, the fundamental consideration is the nature of the learner. We cannot modify the natural method of the child's development to any appreciable extent, so our problem lies in the right interpretation of that development, and in modifying the material to be used in such a way as to secure the most ready reaction on the part of the pupil.* The secondary school student is in the transition stage of development midway between childhood and manhood. His intelligence is not yet fully developed, his experience is limited, and his knowledge, incomplete and unorganized. There is a pedagogical demand that there should be a psychological arrangement rather than a logical arrangement of studies for secondary instruction.^o The logical arrangement is adaptable to adults who are matured with respect to developed intelligence, broad experience, and extended and organized knowledge.

* Rein, Professor W.: "Outlines of Pedagogics," p. 169. Translated by C. C. and Ida J. Van Liew. Bardeen, Syracuse, 1895.

^o Brown, "The Making of Our Middle Schools," p. 412.

From the psychological point of view there are four factors that enter into the problem of determining the proper sequence in presenting the various subjects and phases of agriculture to the secondary school student. These factors are:

1. The apperceptive basis that the individual possesses in terms of previously acquired ideas and experience.
2. The characteristic instincts of the individual during the adolescent stage of development.
3. The economic sanction, which appeals to the student's desire for production and ownership, and by means of which his serviceableness to the race may be enhanced.
4. The previously acquired habits in accordance to which the pupil adjusts himself to his environment.

1. The Apperceptive Factor.

Apperception⁺ is the perception of new things in relation to the ideas which we already possess. If one has many ideas on a certain subject, it will be easier to acquire new ideas with respect to it than if one has only a few ideas concerning it. This principle holds equally true of both adults and children. But as

found

+ Apperception will be fully treated in the following references:
Lange, Dr. Karl: "Apperception: A Monograph on Psychology and Pedagogy." Translated by the Herbartian Club. Heath, Boston, 1894.

Bagley, W. C.: "The Educative Process." Macmillan, New York, 1908. Part II., beginning with p. 66.

McMurtry, Charles A.: "The Elements of General Method." Fifth edition. Chapter VI. Public-School Pub. Co., Bloomington, Ill., 1897.

De Garmo, Charles: "Herbart and the Herbartians," Chapter VII. Scribner's, New York, 1896.

Rein's "Outlines of Pedagogics," pp. 118-20.

interest partly depends upon the ideas already in the mind,^x we may conclude that "apperception is based, primarily, upon interest."^{*} It has also been shown that the more elementary process of apperception is based upon the primitive needs of the individual.^o

The first interests that children manifest in nature, or in the things with which agriculture is concerned, are biological.⁺ Animals and plants very early attract their attention. It is difficult to ascertain whether, in the majority of children of high school age, interest in animals or in plants predominates. Most children, however, upon entering the high school, have a more or less extended and intimate acquaintance with both plants and animals. Most children have pets which enable them to acquire much definite knowledge and experience with a few animals. This knowledge and experience is usually increased by the pets of other children, the domestic animals of the farm, and the wild animals of the neighborhood. Likewise most children, especially those who are so fortunate as to be reared in the country or village, have experience in raising plants in their own gardens or in the family gardens, and the opportunities which they have for becoming acquainted with the many farm plants are very numerous. The school gardens of the cities are now giving to the pupils of the

^x Herbart, John Frederick: "The Aesthetic Revelation of the World." Translated by Henry M. and Emmie Felkin in "The Science of Education." Swan Sonnenschein & Co., London, 1892.

^{*} Bagley's "Educative Process," p. 92.

^o Ibid. pp. 84-5.

⁺ See C. F. Hodge in Pedagogical Seminary Vol. 6, pp. 536-553. Also in "Nature Study and Life," Ginn, Boston, 1902. Chapter III.

Dopp, Katharine Elizabeth: "The Place of Industries in Elementary Education," pp. 110-12. University of Chicago Press, Chicago, 1903.

grades a much needed experience with and a valuable knowledge of the common garden and decorating plants. Not only will children, generally, have a good store of first-hand knowledge of plants and animals upon entering high school, but various agencies will have directed their reading along these lines. Many of the lessons in the readers of the grades are founded on nature studies, and the geographies used by them contain many lessons on plant and animal life. The wide interest shown in nature study, and the sustained emphasis that this subject continues to receive, bid fair to make it possible for every boy and girl of the elementary school to form an excellent basis that may be utilized by the agricultural instruction of the secondary school.

From the experience of cultivating the plants of the garden, and observation in the harvesting of the various crops of the farm, most children will have acquired a knowledge of the simpler garden tools, and a working basis for the study of the most complex farm implements and machinery.

About the subject of soils and the other conditions of plant growth, children below the age of fourteen know but little. The average boy knows in a sort of vague way, that manure and commercial fertilizers aid plants to make thrifty growth, that cultivation, somehow, assists plants to grow well, that moisture is necessary for plant growth, that weeds should be kept out of the crops, that the soil should not be plowed when too wet, that there is something in the rotation of crops, and a few other matters even more vague to his understanding.

Now, according to the principle of apperception, the high school pupil should be introduced to agriculture thru that division of the subject concerning which he knows the most. Evidently this will be one of the biological divisions,-- plants or animals. Since we are unable to determine conclusively, which of these divisions the average pupil upon entering the high school knows most about, and since we are certain that he is sufficiently familiar with either phase to furnish a good apperceptive basis and to inspire a healthy interest, it matters little, from psychological considerations, which of these divisions be chosen for the starting point in secondary agriculture. The working basis which children have of farm implements and farm machinery will perhaps be somewhat more limited than that of the biological studies. On the other hand, it is quite evident that studies in soils and the other conditions of plant growth should be postponed, not only until the pupil has formed a better apperceptive basis for considering them, but also in order that the interests awakened by plant studies may create a strong desire to understand the fundamental principles concerning soil management and the vital conditions of plant growth.

2. The Factor of Innate Dispositions.

The period of adolescence in the individual is a period of very great and rapid development in both bodily and mental characteristics. It is a new birth as well as an age of reconstruction. At this age dormant instincts are awakened and old ones

are emphasized.^x Rightly used these impulses may be wielded as powerful factors in the development of the personal powers of their possessors in laudable directions; but wrongly applied, they may be made the evil geni of his utter ruin. Our problem as school men lies in the effort so to modify the instructional materials in the various subjects of the high school curriculum as to secure an agreeable and helpful reaction of the instincts of adolescence upon the individual.

We inherit neural organizations with paths of least resistance to external stimuli and their consequent reactions. A complex, organized system of stimuli and reactions, made possible by our inherited neural paths, gives rise to instincts. An individual feels himself impelled to perform certain acts without knowing the end to be accomplished, yet as a result of these acts a condition is attained which may better adapt the organism to its environment. Such activities are called instincts.* They furnish the original

x See Hall's "Adolescence;" various chapters on adolescent growth, and especially I. 128 and II. 70 et seq.

William H. Burnham on "Suggestion on the Psychology of Adolescence," School Review, 5: 652-666.

Hollister, Horace A.: "High School Administration," pp. 157-162. Heath, Boston, 1909.

* "Instinct is usually defined as the faculty of acting in such a way as to produce certain ends without foresight of the ends, and without previous education in the performance."--William James in "The Principles of Psychology," Vol. II., p. 383.

Kirkpatrick, Edwin A.: "Fundamentals of Child Study." Macmillan, New York, 1908. This is an excellent work on the development of instincts during childhood and early adolescence.

Bagley, William Chandler: "Classroom Management, Its Principles and Technique," pp. 14, 158. Macmillan, New York, 1908.

Dewey, John: "Psychology," p. 353. Harper and Bros., New York, 1897.

Baldwin, James Mark: "Dictionary of Philosophy and Psychology." Macmillan, New York, 1901. See the article under "Instinct."

basis of education in man. We thus see that instincts furnish us with a biological basis for education.^o They furnish fundamental avenues of approach to the growing mind; besides, thru their activities, consciousness is first awakened and the first raw materials of perception are brot to the mind.⁺

Just as there are different periods in the life of the individual when certain parts of the body experience emphasized growth, so there are periods during which human instincts receive emphasized development. Some instincts develop during infancy, flourish for a time, and then cease to exist, as in the case of the sucking instinct;^x others lie dormant for a time until the physical development has reached the proper stage when they gradually blossom forth in all their power.* Such instincts are called delayed instincts.⁼ Many of these instincts develop and are particularly strong during the period of adolescence.

The first task before us, then, is to search out the dominant instincts of this period, to consider the characteristics of their functioning, to determine the results attained, and to demonstrate the nature of the stimuli that evoke them. The results of such investigation will enable us intelligently to organize the materials of secondary agricultural instruction in accordance with a definite aim, and by the application of scientific principles.

^o Horne, Herman Harrell: "The Philosophy of Education," p. 24. Macmillan, New York, 1909. Chapter II. is entitled, "The Biological Aspect of Education."

⁺ Royce, Joseph: "Outlines of Psychology." Macmillan, New York, 1903. See pp. 219 et seq.

^x Cf. Bagley's "Educative Process," p. 110.

* Kirkpatrick's "Fundamentals of Child Study," pp.8, 44-46.

= Judd, Charles Hubbard: "Psychology, General Introduction," p. 215. Scribner's, New York, 1907.

The dominant instincts in adolescents to which we may appeal by means of the instructional material of secondary agriculture are: aesthetic appreciation, activity, acquisitiveness, curiosity, expression, imitation, and manipulation. There are other instincts that may be enlisted in the work of instruction, but these are quite outside of our present field of consideration. Some of the above classes of instincts overlap with others,^o while some include others that are not here mentioned. For the purpose of clearness and utility, it is advantageous to make such divisions as are given.

Aesthetic Appreciation.⁺-- During the adolescent period the development of the aesthetic instinct-- the appreciation of the beautiful-- becomes a potent factor in determining the activities of the youth. The attribute of ugliness repels, the beautiful attracts. Upon this instinct depends the choice of friends; and the new instinct of love is guided in its expression and bestowal by some evidence of beauty in the object of adoration.^x The child's contemplation of nature during this period is largely due

^oRowe, Stuart H.: "Habit-Formation, and the Science of Teaching", pp. 78-9. Longmans, New York, 1909.

+ Rowe, "Habit-Formation," p. 77.

Judd's "Psychology, General Introduction," p. 229.

Kirkpatrick, Edwin A.: "Genetic Psychology," p. 104. Macmillan, New York, 1909. Also "Fundamentals of Child Study," pp. 209-12.

x Consult Hall's "Adolescence," II. 113, 139. An excellent contribution on the love affairs of adolescents is given in "Paidology," Vol. I. pp. 105-192. Oct., 1902. The editor is Dr. Oscar Chrisman, Ohio University, Athens, Ohio.

to this instinct.* It is true that many of the highest forms of beauty, for example, in art and literature, are often beyond the child's ability to appreciate, and are entirely overlooked; but the harmonious mingling of the colors in flowers, the ripe fruits, the beautifully formed trees and bushes, the greensward, and the waving of grain-- all these may be assumed to call forth pleasurable reactions in the normal adolescent. Such reactions give rise to a very strong interest^o in the object whose aesthetic quality has awakened such pleasurable reactions.

Activity.⁺-- The instinct of activity in the adolescent is very strong, but its functioning is soon followed by fatigue. It manifests itself in many ways, as in construction, expression, imitation, manipulation, play, etc. In the very early years of the individual, his activities are very much at random, but later they begin to become more definitely organized with the result of better adjusting the organism to its environment. At this age of adolescence, the instincts become more certain as to their direction in response to external stimuli. The coordination of sensory impressions and corresponding motor discharges become more firmly fixed. There is a "hungering" for those forms of activity which result in pleasurable reactions. It is noticeable that those studies that require some form of activity are the ones most earnestly pursued by adolescents, and the rapid rise of manual

* See Hall's "Adolescence," Chapter XII., entitled, "Adolescent Feelings toward Nature and a New Education in Science."

^o In the classification of interests, Herbart names this the "aesthetic interest." Herbart, John Frederick: "Outlines of Educational Doctrine." Translated by Alexis F. Lange and annotated by Charles De Garmo. Macmillan, New York, 1909. See Chapter V., and especially p. 90.

+ Hall's "Adolescence," I. 158-165; II. 75-6.

training, domestic economy, and agriculture as school subjects is traceable to the gratification of this instinct. In the arrangement of agricultural materials, allowance should be made for the exercise of instinctive activity.

Acquisitiveness.^x-- The instinct of acquiring things for one's own lies at the basis of thrift. Its economic value is inestimable. In the earlier years of the individual it manifests itself in collecting^o various articles, which may be mere trumpery, such as blocks of wood, broken dishes, etc.; nevertheless, a genuine pleasurable reaction is felt in their possession. To this cause may be attributed the fad of collecting stamps, coins, shells, birds' eggs, etc., which is so prominent in children just before and during the earlier years of adolescence. During adolescence the instinct of acquisitiveness gradually takes the form of ownership of property which can scarcely be classed as a primary instinct.⁺ In the work of secondary agriculture this instinct may be very effectively used in such exercises as the collection of seeds, perfect fruits, cocoons, and specimens of various sorts.

x James, William: "The Principles of Psychology." Two volumes. II. 422. Holt, New York, 1908. Rowe, "Habit-Formation," p. 75.

o Burk, Caroline F.: "The Collective Instinct," Pedagogical Seminary, Vol. 7, pp. 179-207. The same article will be found abridged in Hall, G. Stanley: "Aspects of Child Life," pp. 205-240. Ginn, Boston, 1907. Rowe, "Habit-Formation," p. 75.

+ See Bagley's "Educative Process," p. 198, and the same author's "Classroom Management," p. 168.

Curiosity.^x-- Curiosity, or inquisitiveness, has been defined as "desire to know." It is an intellectual hunger or impulse to secure and test new sensations. In early life it is chiefly imperical, but later it develops into a contemplative (rational) phase. Curiosity thus develops interest and guides the pupil's attention to new laws and phenomena.

Very slight stimuli may, by awakening the driving force of instinctive curiosity, cause the youth to discover very valuable knowledge. Curiosity under a given stimulus leads him to react in a certain direction. A new fact, object, or phenomenon presents itself and evokes instinct with pleasant, unpleasant, or negative results. If the result is unpleasant, the pupil will be repelled by the fact, the object, or the phenomenon that gives rise to the unpleasantness; if there is a negative result, i. e., if the feeling aroused by the exercise of instinctive curiosity is neither pleasant nor unpleasant, the pupil's interest in the thing that evokes his curiosity will vanish and he will no longer attend to it; but if the result is a pleasant one, interest will at once be aroused, and this condition assures attention. Therefore, to secure an effective interest and continued attention in the pupil, it becomes necessary to present the materials of instruction so that they shall result in pleasurable reactions to the instinct of

^x James, "The Principles of Psychology," II. 429; Rowe, "Habit-Formation," p. 75; Hall, "Adolescence," II. 85-6; Kirkpatrick, "Fundamentals of Child Study," 59, 168, 172; "Genetic Psychology", 102; Bagley, "Classroom Management," 152, 153, 154; Angell, James Rowland: "Psychology," pp. 354-55. Holt, New York, 1908. Titchner, Edward Bradford: "An Outline of Psychology," p. 254. Macmillan, New York, 1896. Hall, "Aspects of Child Life," "Curiosity and Interest," pp. 84-141.

curiosity.

Expression.*-- The expressive instinct may manifest itself in many ways, as speech, writing, drawing, painting, making things, etc. Expression is the result of a revealing activity of the mind. To do so, some form of muscular activity is involved. When the expression is successful, a feeling of satisfaction makes the form interesting. Care must be taken therefore, that the forms of expression required shall not be too difficult in the beginning, else the expressive instinct will result in failure and unpleasantness. In such a case the consequent reaction would be disastrous to the development of the right kind of interest and attention.

A very potent phase of the instinct of expression is seen in the making of things. Constructiveness^o is a very strong motive force in high school pupils. That boy is very unfortunate, indeed, who has no back yard or wood shed in which to construct chicken coops, weather vanes, rat traps, cider mills, bean hullers, martin boxes, telephones, etc. Normal boys and girls of adolescent years take great pleasure in making things, because the instinct of expression in this form results in pleasant reactions. The direction that expression will take is fundamentally influenced by the environment in which the individual is placed. The city boy will express himself very differently from the boy reared in the country. The latter may very naturally be led to express himself thru the

* Rowe's "Habit-Formation", p. 76; Kirkpatrick's "Genetic Psychology", p. 106; Titchner's "An Outline of Psychology", pp. 22, 224.

° James' "The Principles of Psychology", II. 426; Rowe's "Habit-Formation," 75; Angell's "Psychology," p. 36; Kirkpatrick's "Fundamentals of Child Study," pp. 207-8, and "Genetic Psychology," pp. 102-3; Bagley's "Classroom Management", 155-6.

medium of a well kept garden or fields of grain, or the care and development of a superior grade of animals. This expressive instinct may easily be provided for in the teaching of agriculture, because of the abundant opportunity afforded for practice work.

Imitation.⁺-- "Imitation is the tendency of the individual to act upon the suggestion of others."^x This instinct begins to manifest itself in the individual about the ninth month after birth and continues to function thruout life.* This instinct is a powerful factor in society. It is especially strong in high school pupils who often acquire characteristic actions and peculiar methods of expression from their teachers and companions. The adolescent learns more thru imitation than is commonly admitted. At no age are "fads" carried to such extremes, and this characteristic is explainable on the basis of the instinct of imitation. "Let me see if I can do it," is a familiar expression heard in the high school laboratory, which implies willingness to learn by imitation. A good use of this instinct may often be made in laboratory practice.

+ An excellent discussion of imitation will be found in Horne's "The Philosophy of Education," pp. 175 et seq.; James' "The Principles of Psychology," II. 408; Rowe's "Habit-Formation," p. 74; Angell's "Psychology," p. 360; Kirkpatrick's "Fundamentals of Child Study," Chapter VIII., discusses the different kinds of imitation. Kirkpatrick's "Genetic Psychology," p. 101. Haskell-Russell: "Child Observation; Imitation," Boston, 1897. See also Tarde's "Laws of Imitation," New York, 1903, for a general treatment of imitation.

x Harne's "The Philosophy of Education," p. 176. Cf. Kirkpatrick's "Fundamentals of Child Study", p. 58.

* Baldwin, J. Mark: "Mental Development in the Child and the Race." Second edition, p. 124. Macmillan, New York, 1906.

Manipulation.^o-- When a new object is brot to the attention of a boy, one of his first impulses is to handle it. This he does with the manifest result of ascertaining its structure, of determining its weight, of securing tactile impressions, and, in general, of securing a more complete concept of the object. The expression, "Let me see it," so frequently used by adolescents, means more than a mere ocular examination of an object. A new ball, a new tool, or some familiar object of a slightly different pattern is at once "tried" to ascertain if it can be used, or to see how it works; a new adjustment is thus secured. The new adjustment caused by a new tool of a slightly different pattern, may, if it result in a pleasurable experience, awaken a lively interest in the pupil. The instinct that prompts to manipulation may be appealed to by those tools and implements which the pupil already knows how to use, and then other tools of different pattern may be gradually introduced.

In the preceding brief discussion of the various types of instinct that may be utilized in secondary agricultural instruction, it has been suggested in each case how the particular instinct might be utilized. These various instincts are evoked by the stimuli from material objects, hence the necessity of basing such work upon the laboratory method.

Not all of these instincts are capable of being appealed to at the same time, but one or more of them may be utilized in conjunction with the other factors that determine the sequence of the materials of agricultural instruction. The object is to insure a pleasurable reaction that shall engender interest. Interest

^o Rowe's "Habit-Formation," p. 76; Kirkpatrick's "Genetic Psychology," p. 299.

begets attention, and attention is the mother of knowledge. It must not be inferred, however, that every pleasurable reaction to instincts leads in the right direction; such a reaction may be the first step in a series, which ultimately leads to ruin.⁺ These must be guarded against, and their occurrence, so far as possible, finally eradicated. The trend of the initial reaction must always be upward to secure the sanction of the true educator.

3. The Economic Factor.

Biology, with its emphasis upon the adjustment of the physical organism to its natural environment, places the practical at the bottom of existence. The first thing is to exist, to live, and this is a very practical matter. After man has met and satisfactorily solved this fundamental condition, he may proceed to the consideration of the more delicate modes of adjustment of civilized life and the pursuit of ideal ends. But these ideal ends must themselves in some way contribute to the problem of living, in the wider sense of mental appreciation, if not in the narrower sense of physical existence, or they become mere phantasms.^x The ideals of life thus receive a practical sanction, because they assist human beings to make better adjustments to their environments-- either natural or artificial. Without such a reason for their existence, they are not worthy of pursuit and should be excluded from the educational system maintained by the people. Education must be in constant touch with life. The logical conclusion of this view is that education prepares the individual for more efficient service in the more comprehensive sense of the term "service".

⁺ Cf. Bagley's "Educative Process," pp. 101 et seq.

^x Cf. Horne's "The Philosophy of Education", p. 53.

It has been shown that during the first years of adolescence children think of things in terms of their uses.* The growing motor ability, the increased knowledge of what is regarded by others as worth while, his enhanced knowledge of commercial values, and a feeling of his responsibility as to the success of his own career, lead the adolescent to a consideration of the economic ends to be gained by his activities.^o At this age the idea of utility begins to dominate that. A new tool or machine, to hold the interest of a high school youth, must have some perceptible relation to practical affairs, if it is to hold his interest. The fact that an object has some use is to him a sufficient excuse for its existence. "Then, and not earlier, come the need of utilities, application of machinery, hygiene, commerce, processes of manufacture, the bread-winning worth of nature knowledge, how its forces are harnessed to serve man and to produce values. Contrary to common educational theory and practice, the practical, technological side of science should precede its purer forms. Here belong economic botany and zoology, the helpfulness of astronomy, the inventions that follow in the wake of discovery, machinery, and engineering novelties based on researches-- or, in a word, how man has made nature work for him." +

The instinctive activities in adolescence will normally result in pleasure simply from the instinctive craving for activity.

* Barnes, Shaw, and Kratz as mentioned by Hall in "Adolescence," II. 486.

^o Keith, John Alexander Hull: "Elementary Education, Its Problems and Processes," pp. 99-100. Scott, Foresman, Chicago, 1907.

+ Hall's "Adolescence," II. 153-4. See also Vol. II., pp. 150, 156-7.

But out of most of the various instincts discussed in the previous section, very strong economic interests develop during the adolescent age. This being the case, the pleasurable reaction is obviously enhanced by the perception of the economic value of any activity. Thus there arises a double sanction: one from the side of primary instinct and the other from the side of reason.

The result of aesthetic appreciation may or may not contribute directly toward an economic end, but the acquisition of any special power in this direction is frequently economically applied. This interest, coupled with special power of expression by means of drawing is of great economic value to the nature artist.

Curiosity may result in economic significance. If some practical and useful idea or object is gained, the pupil feels the glow of satisfaction, and a favorable attitude to the particular situation or fact in question is likely to develop.

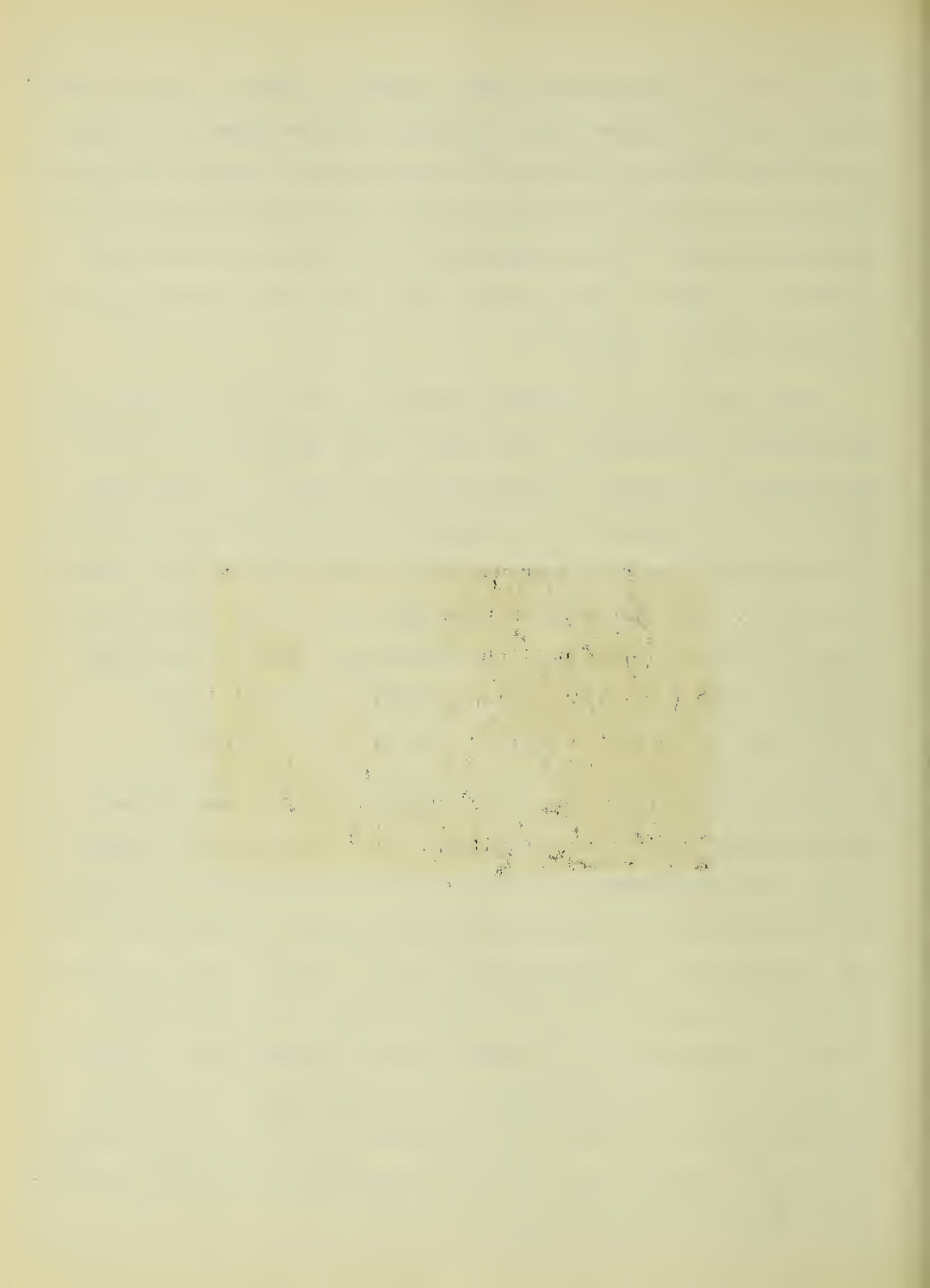
The constructive instinct may be emphasized by leading the pupil to see that the result will possess economic value. How economic considerations emphasize imitation may be seen in daily life on every hand. If one farmer secures a better crop of corn because he cultivated it during a drought while his neighbors did not, the neighbors will likely follow his example from economic motives during the next dry season. The production of economic results is often accompanied by imitative acts.

High school pupils have a clear conception of the relation that exists between certain activities of the farm and the production of economic materials-- food and clothing. The average boy,

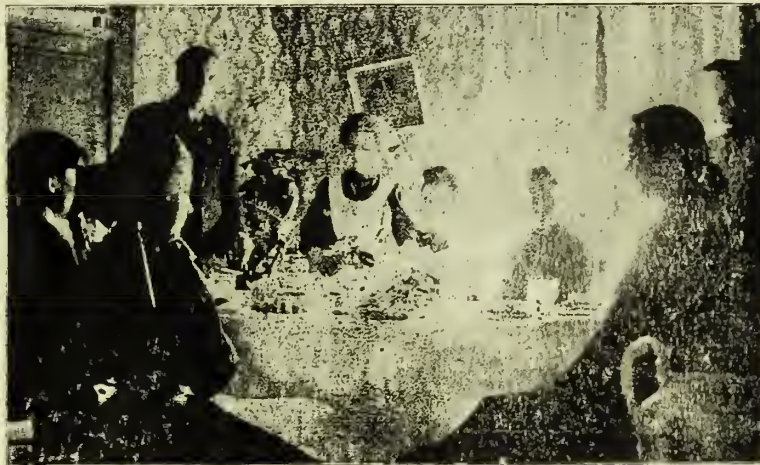
who is given a garden of his own, and who is assured that the proceeds from its produce are to replenish his own purse, will cheerfully apply himself to the art of cultivation. The mere collective instinct of the child develops into the deep-seated desire of ownership of property in the adolescent. He collects articles that possess an economic value. Many things are saved because they may sometime "come in handy."

The mainspring of modern commercial activity is traceable to the desire of ownership. The result is the acquisition and the production of property. Productive labor comes to be utilized. Effort is not measured by the hands of the clock when an individual's interest has been awakened and is sustained by this instinctive desire. The shop laborer begrudges the service that he gives after the whistle blows until he becomes the owner of the shop. The boy on the farm will develop a greater interest in its activities, if he owns a share of it, or of its produce.

We thus see that when consciousness, purpose, and reason modify these instinctive activities, the economic factor becomes a strong directive force. The result of the individual's activity is the attainment of some advantageous position or adjustment, or the acquisition of some economic object. He often secures these thru the imitation of the actions of others. He is curious to discover something new and useful, and by manipulation he ascertains what that usefulness may be. In expression he satisfies his own desires or constructs to administer to his own usefulness. He acquires objects thru collection and production, which contribute to his own personal enjoyment.



Since the economic factor is so strong a compelling force in awakening and accelerating the learning process in the adolescent, there is every reason why the place to "take hold" upon any phase of agricultural instruction should be where the economic sanction is most evident. This appeal to the primitive interests should not be regarded as the ultimate end to be reached. It only serves as a means, as a starting point, thru which more remote ends of education may be the more easily attained. From this point we must gradually proceed to higher orders of interest,^x to loftier ideals, and to the ability and desire to render more efficient service to one's fellows.



The economic factor and life.

^x Bagley's "Classroom Management," pp. 168-9.

4. The Factor of Acquired Dispositions.

One of the most potent factors that determines the functioning of an individual is his previously formed habits. If we know the habit and the stimulus under which it has been developed, we can predict with a reasonable degree of certainty the activity of individual when the given stimulus is presented to him. One would indeed rarely fail correctly to predict what the activity of a ball player would be if a ball were tossed at him. Likewise, one would be astonished should a farmer boy, upon being presented with a hoe, proceed to split wood with it. The sight of the moving ball would excite the motor actions necessary for catching it; and the hoe would furnish the stimuli that would put into operation a set of muscles necessary for cultivation with the implement in question. The ball player might dodge the ball and allow it to pass on, but that would be the exception; and the boy might attempt to balance the hoe on the end of his chin, but that would not be the natural result.

"Habit is anacquired aptitude for some particular mode of automatic action."* It differs from instinct in that an instinct is inherited, while a habit is an organized reaction built up in the course of the individual's lifetime.^o From this standpoint, a habit may be defined as that mode of behavior which depends upon individual experience.⁺ Habit, then, is the mass of automatic

* Rowe, "Habit-Formation," p. 47; James, "The Principles of Psychology," Vol. I., Chapter IV., entitled "Habit."

^o Bagley's "Classroom Management," p. 15.

+ Judd's "Psychology: General Introduction," p. 216. See Bagley's "Educative Process," Chapter VII. for an excellent discussion of "Experience Functioning as Habit."

reactions built up during the life~~time~~ of an individual. It results upon the successful accommodation or adaptation of the organism to its environment.

Habits are primarily dependent upon instincts, which furnish the original impulses that are finally built up into automatic action by repetition.^x Instincts are not always adequate to the needs of life; these impulsive activities must be selected in the light of experience, organized and automatized,-- in other words, instinctive activities must be modified and translated into habits, which adapt the individual to conditions for which mere instinct is inadequate.* A very important function of education is the formation of good habits, that is, regular and serviceable reactions to life's stimuli.^o

We may classify habits into two classes: first, those habits that concern the purely mental activities; and second, those that have to do with automatic motor action.⁺ In the first class, stimuli excite and develop certain brain paths, and succeeding stimuli tend to arouse the same thot or thots.⁼ People thus fall into the habit of thinking in the same way that they have previously thot, i. e., one thot gives rise to a thot or a series of thots, which always follow in the habitual order. Again, a certain

^x Judd, "Psychology: General Introduction," p. 216; Rowe, "Habit-Formation," p. 70; Royce, "Outlines of Psychology," p. 220.

* Cf. Bagley's "Classroom Management," p. 110.

^o Horne's "The Philosophy of Education," pp. 54-5.

⁺ Cf. Rowe's "Habit-Formation," p. 47.

⁼ Royce, "Outlines of Psychology," pp. 66, 198. Andrews, B. R.: "Habit." American Journal of Psychology, Vol. 14, pp. 121-149.

stimulus may habitually give rise to a certain idea. The stimulus, $2 + 2$, may be depended upon to give the idea of 4 to those who have developed the habit. Still again, certain stimuli may awaken an habitual mental process or an habitual mode of thinking. A lumberman looks at a tree and his thots concerning it are of an economic nature; an artist looks at the same tree and he thinks of it in terms of its aesthetic qualities. The minds of both men function in their habitual ways; the results are very dissimilar, tho the stimulus is identical in either case. Thus the mental law of apperception depends upon habit. But we are chiefly concerned with the second class of habits,-- those that involve motor response.

It is well known that habit and **perception** develop together: one is the handmaid of the other. Correct perceptions tend to guide the organism in the development of good habits, while the organism's habits have a clarifying influence upon perception.* The development of organized perception and of organized activity always go hand in hand. The automatisms by which the bodily adjustment to a hoe is gained, give the boy a much better idea of hoeing than he would otherwise have. "The training of eye and hand in any technical art, of ear and vocal cords in singing or speaking, of ear and hand in playing a musical instrument, go together in practical experience. The expert in every line not only acts more skillfully, but he sees or hears more skillfully and comprehensively. Perception is discriminate and complete just

* Judd's "Psychology:General Introduction," p. 175.

in so far as the factors of experience are organized into wholes appropriate for individual reaction." °

Habits may also be made the basis of interest. The essential condition of habit formation is that the reaction from the movement that it is desirable to automatize be a pleasurable one: otherwise the habit may not be formed. + Pleasure from the execution of acquired dispositions is as natural, therefore, as pleasure from instincts. x Besides, habits develop propensities to activity in some certain direction upon the presentation of a given stimulus. There is always a feeling of naturalness in the performance of habitual acts, but if the acts are inhibited and the habit is not allowed to follow the stimulus to which it is accustomed to respond, there is a feeling of ^{un}naturalness,-- a genuine discomfort. * This pleasurable reaction may be made the basis of interest. The automatisms developed in learning to milk, may be made the basis of interest in the principle and the construction of the milking machine. The automatic movements accompanying the tying of an ordinary knot contribute the most vital element in the interest manifested in learning to tie other knots such as the weaver's knot, or the bowline knot. The motor habits of spading will contribute an element of interest in learning how to dig a ditch.

Acquired habits hold somewhat the same relation to new ones as ideas already in the mind hold to new ideas. The formation of

° Judd's "Psychology: General Introduction," p. 175.

+ Kirkpatrick's "Genetic Psychology," pp. 113-15.

x Judd's "Psychology: General Introduction," p. 228.

* Rowe's "Habit-Formation," 35.

a new habit will be modified by the habits which the organism has already formed. "In any given situation the thoughts, feelings, and acts manifested will be those to which instinctive tendencies, or capacities, and also previously formed habits impel one." ° In learning to tie a sheaf of wheat one's movements will be modified by the previously automatized movements of the muscles now concerned. The automatisms acquired by lacing one's shoes, tying one's necktie, braiding, etc., will facilitate the acquirement of the automatic movements in learning to make the splices of ropes. Thus, in a measure, new habits are developed out of old ones. +

The subject of habit formation is one that has not been extensively written upon, and the idea of developing a systematic series of habits, i. e., automatic actions, to be acquired by pupils in a given course of instruction is of quite recent development in educational science and practice. In the present status of habit training in the elementary school, pupils enter the high school without any adequate uniformity in the automatisms that they have acquired. It is true that a class of pupils often do possess many automatisms in common, but until greater progress is made by systematic habit training in the elementary school, the high school must content itself with using such automatisms as its pupils have incidentally acquired, or assume the responsibility of first developing those habits that it wishes to make use of in later instruction.

° Thorndike, E. L.: "Elements of Psychology," pp. 199-204. The italics are our own. Seiler, New York, 1905. Cf. also Kirkpatrick, "Fundamentals of Child Study," pp. 82 et seq.

+ Rowe, "Habit-Formation," p. 71; Royce, "Outlines of Psychology," pp. 231-5.

The habits that high school pupils have previously formed bear a very important and close relation to the organization of the materials for secondary agricultural instruction. Previously acquired habits very fundamentally influence future acts. Habits are stable and lasting to a degree quite equal to that of instincts and far greater than that of ideas. If ideas and instincts are sufficiently important to be considered as determining factors in the organization of teaching materials, we see no reason why habits should not also be so admitted.

CHAPTER IV.

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THE SEASONAL DETERMINATION OF SEQUENCE.

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In our zone, most of the phases of agriculture are dependent upon the various seasons. Spring and seed-time, autumn and harvest, are ideas that have been associated with each other for ages. Plant life, generally, is deeply influenced by these cycles of the year; and as plants bridge the gap between the inanimate earth and animal life, the activities of animals, even man, are profoundly modified by these periodic activities and dormant states in the vegetable world. Those animals most directly dependent upon plant life for existence are most directly influenced in their habits and activities. That class of men, which is most closely related to plant and first food production is likewise most vitally influenced. The agriculturists compose this class.

The importance of keeping pace with Nature in her seasonal progress with all our agricultural activities is a very ancient idea. One thousand years before Christ the Greek poet, Hesiod, set forth the necessity for such observance in his great poem, "Works and Days."* This is a lesson which the race has always had to keep in mind, and failure in its strict observance in agricultural practice has often caused the appearance of the "wolf" before the peasant's door in the depth of winter, and even Death has gone

* Anderson, Robert: "The Works of the British Poets." John and Arthur Arch, London, 1795. Vol.13, pp.4-38. This is an old translation accompanied with rather copious notes.

stalking thru the land. Even in these modern days with all our superior methods, there are examples of farmers in almost every community who persist in "bringing up the rear." Their usual rewards are great labor and small returns. This is a lesson which the young farmer needs to learn-- the inestimable lesson of punctuality.^o We thus see the importance of a seasonal sequence from the standpoint of the agriculturists. Our next step is to ascertain if a pedagogical use may be made of this fundamental requirement.

The school year in the United States begins about the first of September and ends the latter part of the following May. There are two periods during this time when the seasons will permit the study of plants-- the spring and the fall. In botany, studied from the standpoint of pure science, the study of the living plant is usually reserved until the spring months; but viewed from the applied science approach, and from pedagogical considerations, this custom is seriously questioned as being conducive to the best results. This point will be further considered hereafter.

If the work in secondary agriculture is begun immediately upon the opening of school in September, it is possible to begin with the study of plants. There are phases of plant growth that need to be emphasized at this season. Seeds need to be selected at harvest time, careful storage of grain and fruit should be considered, and the reasons for such procedure explained and

^oMain, Josiah: "Some Factors in the Making of a High School Course in Agriculture. II. The Seasonal Requirement." Education, Vol. XXX. pp. 220-5.

demonstrated; damaged fruit that might have been saved may be examined and the methods of preventing such damage considered. To this season belongs the judging of the matured crops of all kinds, and a genuine interest in and a desire for superior fruitage will be inculcated at the start of the course when it will most contribute to the real success of the study.

Animal studies may very appropriately begin after the convenient plant material has been somewhat exhausted, and the cold winter weather has set in. The farm animals are now sheltered, and, if they are not, the importance of so caring for them may readily be pointed out. The principles of feeding and the effect of rations may be applied to better advantage now than at any other season, and the results of such demonstrations will be more striking and lasting. There will be especial opportunities for emphasizing the necessity as well as the desirability of the principles of sanitation in connection with the housing of animals. The fundamentals of dairying and the principles of poultry raising may be nicely adjusted to the school program, and the advanced winter prices of animal products will serve to emphasize the increased cost of winter care and the desirability of an increase in the production of these articles .

Before the bursting of the buds of spring, the attention of the class in agriculture must be turned to the consideration of soils. The freezing and thawing effects upon soil may be made very evident at this time of the year. The physical characteristics of the soils, their behavior and actions under varying conditions may be studied in the laboratory quite as well as in the

field or even better, since these conditions may be regulated at will; hence, it is not necessary to wait for the season of cultivation in order to begin this phase of the work.

The plant studies of the spring are not, from the standpoint of the agriculturist, essentially studies of the plants merely, but studies of the conditions of plant growth. The aim is to determine the conditions under which plants will thrive best, and then seek the true explanation of these reasons so that the principles deduced may be remembered and later applied to actual agricultural practice. The study of soils thus becomes vitalized by the dependent condition of plant life. Insect studies come now to be of great concern, because the danger from insect pests to plant life, fruit, and grain noticed during the preceding fall becomes imminent. The principles that were learned in the laboratory may now be applied, fertilizer tests may be started and carried forward, the principles of cultivation may be studied and demonstrated, and scientific farming becomes a reality. Thus the knowledge that has been acquired thruout the school year becomes a living experience, a practical benefit, a source of profit, and, best of all, makes the youth capable of rendering the highest possible service in his profession to mankind.

A little reflection will reveal the fact that there are agricultural subjects to be considered that do not seem to fit into this general plan; that the seasonal sequence will not everywhere coincide with the pedagogical sequence. Whip grafting, for example, should be taught in the winter months when it is most convenient for the farmer to do that kind of work. Gardening under glass

should also begin in late winter,-- early plants should be started, pot-cultures grown as demonstrations, cuttings studied and made, and other work usually included under this head should be carried on. But it will readily be observed that these seeming exceptions, may readily be adjusted, and do not in the least invalidate the plan nor make it less serviceable.

There are three important advantages to be gained by compliance with the seasonal determination of sequence. (1) Materials will always be on hand or easily procurable, and the delays so often experienced from this source in secondary science instruction will be obviated. (2) The community interest will be at its height in each particular phase just at the time when the pupils at school are studying it. This will enlist the aid of the parents and the community in general, and a course in secondary agriculture, which at first is introduced on trial will thus become a fixed part of the school program. This interest of the community will offer an excellent opportunity for the propagation of the more fundamental principles of farming among those farmers who have not had the opportunity to study them, or who have been too indifferent to heed the appeals for better farming. (3) Right habits of procedure will be formed. Habits of doing certain things at given times are absolutely essential in successful farming. The habit of selecting seed corn in the autumn, of harvesting at the proper time, of storing grain properly, of grafting, mending tools, and doing other things that may be scheduled for the season of least activity, of cleanliness in milking, of testing the vitality of seeds, of starting early plants on time, of plowing

when the season permits, of cultivating when the conditions require-- these are only a few of the habits that should be established in the life and activities of every successful farmer. As the subject of habit formation is coming to be regarded as of primary importance in education, it at once appears that the seasonal sequence in the study and teaching of agriculture partakes of a double importance.

SECOND PART.
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CHAPTER V.
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THE ORGANIZATION OF THE COURSE.
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The problem of this chapter will be to organize the materials of secondary agricultural instruction in accordance with the principles established in the preceding chapters. The seasonal determination will necessitate a sequence of materials in accordance with the seasons, and the psychological determination will necessitate a sequence in accordance with (1) the apperceptive factor, (2) the factor of innate dispositions, (3) the economic factor, and (4) the factor of acquired dispositions. Each of these determining elements is fundamental, and the procedure in secondary agricultural instruction must be in harmony with them. This systematic arrangement in the sequence of the materials of instruction will constitute a course in secondary agriculture. These matters will be treated under five general heads.

1. Plant Studies.

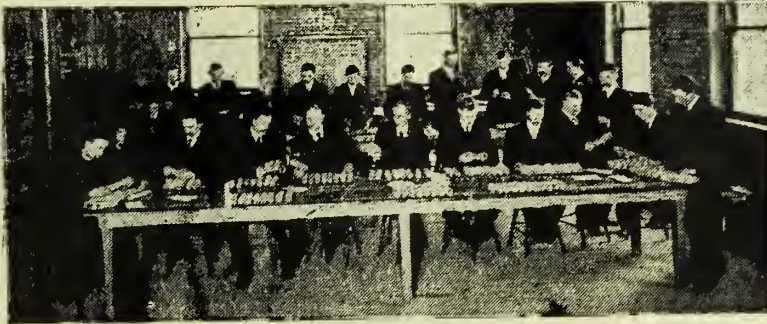
As before pointed out, the best time to begin plant studies from the standpoint of the economic factor in education is in the autumn, at the harvesting time, when the ripened fruits and grains may be utilized to furnish the basis of an economic approach. Fruits and grains appeal to the primitive interest of satisfying hunger. These are the products that plants yield for feeding mankind. Out of the fibers produced by plants cloth is woven, which

is used to clothe mankind. The first real interest of the human race in plant life must have been an economic one. The strongest interest that the individual has in growing crops is essentially economic. Plants should first be considered from the standpoint of food, clothing, and profit. Quantity and quality of production will naturally follow and to secure these ends, the nature, habits, structure, development, care and cultivation of plants, diseases and their treatment, pests and their eradication, etc., will necessarily have to be considered. The opening of school in the fall of the year, at which time it is presumed that the course in secondary agriculture will begin, permits the study to take an excellent economic turn, and abundant opportunities are offered for first hand observation of the final results of the year's growth.

In accordance with the principle of apperception, those fruits and grains, and the plants producing them, with which the pupils are best acquainted, should be first studied; these should be followed by the less familiar products and plants, and finally the least familiar or strange ones should be studied.

Suppose, for example, that the class begins its plant studies with maize. This plant is chosen because no other domestic plant is so familiar to the average adolescent of this country. Ears of corn are seen on every hand thruout the year by the children of country and village. These objects at once arouse the interest of the students, and corn judging may at once begin. This study will naturally lead to the characteristics of the individual plants that produce the best ears of corn, the conditions, cultivation,

and the various circumstances involved in the production of a superior quality of this cereal. Similarly, wheat, oats, cotton, apples, pumpkins, et cetera, may be studied.



An economic approach to plant studies.

2. Animal Studies.

As with plant studies, so animal studies will begin with an economic approach. Butter, milk, eggs, wool, meat, etc., may be considered as articles of food, clothing and profit. These things appeal very strongly to the primitive interests of the pupil, and afford an economic sanction for their study. There will again arise promptings to consider the conditions whereby the production of these articles may be increased and improved. The animals themselves will receive due consideration, and so, from point to point, as many phases of animal husbandry may be considered as may seem desirable and as time permits.

Of course, the apperceptive basis will require that the animal products, and the animals producing them, most familiar to the student be first studied. Other farm animals may then be considered in accordance with the amount of knowledge which the average

pupil possesses of them. The economic approach suggests that the product of each animal should always be studied first, to be followed by a study of the animal producing it. Thus in animal studies, a plan of procedure is followed similar to that used with plants. Milk offers an excellent and familiar object with which to begin the study of the cow, her care and feeding, the dairy type, butter, and, in a word, all about the elementary principles of dairying.



An economic beginning in animal studies.

As suggested in a previous chapter, in the winter season animal products will always be found a convenient and interesting starting point.

3. Machine Studies.

The knowledge which children have of the common farm and garden implements and machines may well form the apperceptive basis for studying farm machinery. Such simple tools as the hoe, the rake, the spade, and the shears may be hastily reviewed, and the principles of each considered, and the proper way to use them demonstrated. The pupil who has developed habits in the use of

these tools will doubtless experience a pleasurable reaction in this last exercise, if not pushed to the extreme of monotony or fatigue.

The propensity gained from the habits acquired in the use of the various garden tools and the operation of the simpler machines of the garden and farm should be understood and a pedagogical use made of them whenever possible. A lever may be pulled just for the satisfaction gained in satisfying the propensity of an automatism previously acquired in the operation of the machine. When such propensities are manifested, there will be interests present, and the teacher should be on the watch for them. If a lever is automatically operated it will be very easy to interest the operator in the reasons for securing certain results by such operation. The construction, the adjustment, and the relations of the various parts of the machine concerned in the lever action should be studied, and from these attention should be directed to other parts of the machine.

After a machine, such as the mowing machine, has been carefully studied, it would be proper to allow the pupil to take the machine apart and then set up again. This will be gladly undertaken by normal boys, since a direct appeal is made to the constructive instinct.

The economic factor may be employed to advantage, especially in communities where farmers are in the habit of allowing their machinery to remain out-of-doors, exposed to the weather thruout or during a part of the year. The damage thus caused and the

consequent loss will emphatically emphasize the necessity of keeping farm machinery well housed at all times.



An economic waste on the farm.

That season of the year when there is the least activity in strictly agricultural pursuits affords an excellent time for the study of farm machinery. Sometime during the winter months all the machines and implements of the farm should be examined, oiled to prevent rust, and the weak and broken parts placed in good repair.

4. Soil Studies.

Man's attention was directed to the consideration of the soil when it began to fail in productiveness. When, after long periods of cultivation, large areas of land became visibly less fertile, and plants were raised with much greater difficulty upon these areas than upon new ones, man began to recognize that a vital relation exists between the soil and the vegetable life which grows in it. It must have been early noticed that manure, and other decaying materials increase the productiveness of the soil

and that careful cultivation will hasten the growth of the plants and conserve the moisture. Each race has had its Squantos and its Tulls who gave to mankind a new vision. It was a long time, however, before the real cause of the loss of fertility of the soil was discovered, altho many of the conditions by which this fertility may be renewed and maintained were known many centuries ago. Soil fertility and the proper management of the soil continue to be of vital interest to every progressive farmer to this day. The incentive for this lively interest is an economic one, and this, together with curiosity to learn reasons, should furnish the basis for securing the interest and the desire of the high school student for the study of this topic.

The study of soils may well begin with simple soil-fertility tests in the high school greenhouse,* with which every high school that pretends to teach agriculture should be equipped. The progress of this test will raise the questions of the sources of soil fertility and its maintenance, the different types of soils and their physical properties, the relation of water, heat, and air to soil, and many other interesting and important questions connected with soil studies.

As before suggested, this work may be satisfactorily done in the laboratory during the latter part of the winter season. A good supply of the different types of soils should be stored away in the fall for use at this time.

* Grannis, F. C.: "The High School Greenhouse." The Illinois Agriculturist, XIV. 23-4.

The question of the care and use of manure may also be considered in this connection. The waste on the average farm resulting from carelessness and ignorance in this respect should be observed and the proper methods^{of} caring for manure should be illustrated. The effect of manure upon the soil may be illustrated in the laboratory and the greenhouse. Samples of commercial fertilizers should be collected, and the elements composing them should be noted.

5. Conditions of Plant Growth.

Under this head we have a combination and application of many of the principles that have been previously learned concerning plants and soils. The intimate relation that exists between plants and soils, moisture, temperature, light, fertility, and cultivation cannot be ignored, and naturally and logically should come at the end of a course in agriculture. From an appreciative standpoint, it is plain that the pupil should have clear ideas of plants and soils and their many aspects before he begins the study of the relations that exist between them. It is in the spring of the year that this relation between the plant and its environment, including the soil, is most apparent.

(a) The Greenhouse. The first studies in plant ecology may be commenced in the greenhouse. The effect of drainage upon soils and plant growth, the regulation of moisture conditions by the use of manure and mulch, the effect of cultivation on moisture conditions, the temperature conditions on plant growth, germination tests and the most favorable conditions for the germination of

various seeds, potting and resetting plants, the use of liquid manure, inoculation demonstrations, propagation of cuttings, the starting of early plants, and plant breeding are some of the activities that may be carried on to advantage in the high school greenhouse during the months of February, March, and April. The construction and use of hotbeds, and coldframes may be studied, and practice given in these activities.

Every effort should be made to place the greenhouse, hotbed, and coldframe on a paying business basis, and the funds so realized should be applied to the maintenance of the greenhouse; to its care, which should be entrusted to one or two earnest pupils with a fair remuneration for work outside of class practice; and to additions and improvements. Little trouble will be experienced in disposing of the greenhouse crop of early tomato, cabbage, and other plants for the garden. Geraniums and carnations, etc., grown from cuttings should also find a ready sale. The class will readily discover other sources of profit, which they should be encouraged to realize so long as the work planned for the course is not hindered. Thus will the interest be increased and the principles involved will be made more vital.

(b) Field Operations. When spring opens up so that planting may be safely begun in the open, garden and field operations should be commenced. Rotation plots, fertilizer plots, and such other garden and field demonstrations, practice, and studies as the class is able to execute should be started and carried forward. An effort should be made to place this work upon a paying basis. If this is done, not only an economic appeal is furnished, but an

excellent opportunity is given for teaching methods of keeping farm accounts, and actual training in the same may be had.

It should be remembered that it is not the object of the high school to produce professional agriculturists, but to teach the elementary scientific principles involved in agriculture as a part of general culture. It is no more the duty of the high school to produce professional agriculturists than it is to ^{produce} business men, lawyers, physicians, or teachers. Pupils should be given enough practice in the application of agricultural principles to enable them to use such principles should they elect farming for a life work. When these pupils become farmers, then they will be enabled to give their entire time and attention to the work of farming: for the present, however, they are being educated.

The pupils will enjoy the practical work until they have learned how to do it; but after this point has been reached, there will be danger of carrying some of the exercises to the extreme of monotony or fatigue. Care must also be taken not to infringe upon the time of the pupil, which he should devote to other courses of the school. Class work is necessarily regular and limited, and the extra attention demanded by the growing crops should be arranged for from another source than that secured at class periods. In this work, as in the case with the greenhouse activities, provision should be made to have the work of cultivation and tending, for the most part, placed in the care of some responsible person or persons. Often members of the class may be induced to take the extra care of a section of a garden for the produce that it will yield.

The great and ultimate object of raising the usual farm crops is to feed, clothe, and shelter man or beast. It is an economic aim, and involves the production of the greatest amount of superior plants, with the least diminution in the fertility of the soil. The desire of the pupils to raise fine specimens of plants in large quantities can be easily appealed to. The necessity for applying the best methods of agriculture, which involve scientific principles, become imperative. The necessity of preventing any unnecessary deterioration of the soil becomes at once evident, and the duty of the present generation to relinquish to the next an unimpooverished soil should be implanted in the young agriculturist to be truly and faithfully realized. Thus shall he not live for the present alone, but for the unknown ages yet to come.

In such an organization of agriculture for the secondary school, we have the economic approach, the economic sanction, and applied science-- all of which are so necessary to the most efficient development of the adolescent. Man's interest in agriculture began in the things which he most needed. So in each division of the subject given above, he first developed interest in those things which were of the greatest and immediate service to him in the satisfaction of his primitive needs. More directly than any other industry agriculture supplies mankind with the articles that satisfy his primitive needs. These things require, in the child, an apperception of low degree. * Primitive needs,

* See Bagley's "Educative Process," pp. 94-5, where apperception of low and high degree is fully and clearly discussed.

such as are required to satisfy hunger and protect one from the elements, are capable of awakening the interest of the child and the young adolescent most easily.^o The economic approach and strong sanction appeal to a very strong instinct in the child.

But secondary agricultural education must not stop here; it must advance to things that require apperceptions of a high degree. Agriculture is no longer primitively apperceived as merely a means to satisfy primitive wants.⁺ We also attach a higher significance to it, e. g., ornamental gardening and floriculture, which have for their aims the satisfying of the aesthetic appreciation of mankind; or the preservation of the fertility of the land, which anticipates the husbanding of the wealth and the power of the nation, and the amelioration of the conditions of life of future generations of mankind; or the recognition of an omnipotent Power that animates all life and that lies at the very genesis of natural production. Not primitive interests, but secondary ones need to be awakened in the life of the youth. These are the ones that fire his ambition, electrify his energy, and clarify his vision of life. From the study of the materials in the order indicated, deductions and generalizations may be made and formulated; then the right application of science to the art of food production becomes clear and possible. The relation of education to life becomes apparent, and the ensuing result is enhanced power of service, together with a desire to be truly serviceable. The knowledge thus gained will be practical; it will also be cultural. The economic

^o Dopp's "The Place of Industries in Elementary Education," p. 112.

⁺ Bagley's "Educative Process," pp. 84-5.

approach will result in the acquirement of as much or more knowledge of the subject ^{than} ^ would result from a pure science approach, besides the former will leave the added power of ability to use.

In familiar pedagogical language, then, proceed from the things that are most familiar to those things not so well known, and then to the strange in the pupil's experience; from concrete examples to abstract principles; from economic considerations to truth for its own sake; from the primitive needs and interests to secondary interests and ambitions; from the real to the ideal. The immediate, economic, realistic incentive is used as a motive force by means of which the individual is impelled onward and upward and finally attains an ideal, which quickens his realism into active altruistic service.

CHAPTER VI.
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THE ORGANIZATION OF THE LABORATORY WORK.
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It is very evident, from the preceding discussion, that the laboratory work of secondary agriculture should be something more than a mere performance of a number of exercises at stated periods. The laboratory and field work becomes the very basis of agricultural study, and as such, it should be carefully organized in accordance with the psychological and the seasonal determinations of sequence, which are established in chapters III. and IV.

From the standpoint of the seasonal requirement the exercises should be so selected as to conform as nearly as possible to the various seasons of the year. If this is done there will always be an abundance of materials available for the use of the class. This requirement will be readily met, if the various exercises are taken up in accordance with the organization of the course as presented in the preceding chapter. The exercises should be classified into five groups, each group corresponding with one of the divisions in chapter V.

The psychological requirement should be followed in conformity with securing the best mental development of the pupil. Under each of the groups of exercises, the first ones should be simple and deal with objects that are familiar to the pupil; they should appeal to one or more of the instinctive factors; their practical

use or value should be quite evident so as to secure the economic sanction of the pupil; and they should, if possible, appeal to the motor propensity of his automatisms. From these primary requirements, the experiments may gradually become more complex, they may increasingly appeal to the higher secondary interests of life, and the narrow and selfish appeal to the individual must be replaced by altruistic ideals and the desire of service for others.

1. Kinds of Exercises.

The laboratory and field exercises of secondary agriculture should not all be cast in the same mould, but should be considered with respect to the end in view. There are four general aims to be attained by the laboratory and field work of secondary agriculture: the discovery of new truth by the pupil; the demonstration, by the instructor, of facts which it is desirable the pupil shall learn; the verification of facts which the pupil already knows for the purpose of clarifying and intensifying his knowledge; and practice in the practical application of his knowledge, by means of which he shall receive motor training.

Discovery.-- The exercise by which the student discovers new truth may be designated by the word "experiment." In performing an experiment, the student assumes the rôle of an investigator. He is to experiment with the object of discovering a new truth, or a new principle, i. e., new so far as the pupil is concerned. As the investigator has a fairly clear idea of the thing that he desires to accomplish, and a knowledge of the various related facts and the relation these likely hold to the new thing to be discovered, so the pupil in performing an experiment should first have clearly in

mind the object of the experiment, the reasons for performing it in a given way, the probable relation of facts which he already knows to the new one under investigation, and a knowledge of the probable causes of error. It is evident that such work is of a very advanced nature and should be attempted only after the fundamentals of the subject have been gained and a good degree of skill in laboratory methods has been acquired. These experiments of discovery should, therefore, be placed at the end of each group of exercises. So far as possible, they should be individual and never more than two pupils should be permitted to work together.

Suppose, for example, that an investigation were to be made of the effect of a surface mulch upon the conservation or dissipation of moisture. The pupil should understand that the purpose of the experiment is to ascertain what effect a surface mulch will have upon a given amount of soil; he should know something about evaporation and capillarity and the probable relation of these facts to the loss and the supply of moisture to the surface soil; he should understand why it is necessary to make two tests-- one with a mulch and the other without; and the possible sources of error should be understood by him. (See Exercise No. 7 , p. 89.)

Verification.-- The exercise by means of which the pupil confirms the statement of a fact or principle which he has read or heard may be called a verification. Both the object of the exercise and the result to be expected are known by the pupil. He satisfies himself that the statement of a certain principle or law is true. So far as possible, verification exercises should be worked out by individual pupils, and not more than two should ever work on the

same one. Before beginning such an exercise, the pupil should be thoroly informed regarding its nature, the method of procedure, and the principle or law which it illustrates.

It is by means of this kind of exercise that the pupil acquires skill in the use of laboratory apparatus and receives valuable training in laboratory and scientific method. Abstract ideas are thus objectified, the proper relation of facts perceived, and natural phenomena come to be correctly interpreted. The pupil's own knowledge will be clarified and his power of grasping and retaining truth will be enhanced.

The pupil may have read or heard, or the teacher may tell him, that the peel of a potato prevents the loss of the water that it contains. It would not be advisable to use the exercise by means of which this fact is proved as a demonstration, since the time required for its completion would be too long. The better plan would be to have the pupils verify the statement by means of the directions given in Exercise No. 2 , p. 84 .

Demonstration.-- The purpose of the demonstration is to teach a certain principle or fact to the class by means of a combination of materials and conditions manipulated and controlled by the teacher. It is an inductive method of teaching. The teacher, but not the learner, is supposed to have fore-knowledge of the result. Each step in the demonstration should be carefully interpreted either thru explanations by the teacher or thru answers to well selected questions by him. The class should be directed when and how to make observations. Every demonstration

should be followed by searching questions on the part of the teacher and concise and definite answers on the part of the pupils. Conclusions should be drawn and principles or laws stated at the end. The exercise should never be concluded until the aim striven for is fully realized. The demonstration thus becomes the basis of inductive instruction, which should be further supplemented by reading in various books, bulletins, and papers. As a rule demonstration exercises should be short so that they may be completed in one recitation period.

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Suppose a lesson is concerned with the reason for storing seed in dry places above freezing temperature over winter. The first step will be to call the pupil's attention to the fact that it is only the moisture in the seed that freezes, and not the substance of the grain. His experience will readily lead him to perceive this. The next step will be to show him that there is moisture in the grain. This may be perhaps most efficiently done by means of a demonstration. (See Exercise No. 1 , p. 84.)

The fact that there is moisture in seemingly dry seeds may be quite as well taught by means of an experiment, or a verification as by means of the demonstration. The advantage of the latter exercise over the former two is the brevity of time required thoroly to teach the fact desired. The experiment by its very nature requires much time; on the other hand, it is not always desirable to have the pupil verify every fact or principle to be learned. The performance of the demonstration by the instructor will furnish the pupils with examples of procedure and many useful hints, which they may imitate in performing their

own verifications and experiments.

Practice. -- The aim of practice work is to enable the pupil to acquire skill in the practical application of his knowledge. It is also a means of expression. Most pupils know more than they can do. In agriculture it is not enough for the pupil merely to learn a principle; he must be able to apply it. He must not merely know how a process is performed, but be able to perform it himself. By doing he receives training, and the reaction from doing successfully gives him consciousness of power. By doing, the pupil may also learn many details that he had previously overlooked.

If the exercise is to be practice work in the laboratory, greenhouse, or field, the particular thing to be done should first be explained and performed by the teacher as an example. The greatest difficulties should be carefully pointed out and directions given how best to master them. The teacher thus helps the pupil to develop the idea of the habit, which is the first phase in habit getting.* The pupil should then be given opportunity in the practice of securing the particular adjustment, or adjustments, in question. The pupil will at first proceed by imitation, and to be successful in this he should be directed to give his attention to the particular activity that he is trying successfully to execute. From this focalization of consciousness and drill, he will develop a permanent adjustment to the environment given him and the result will be a habit.°

* Rowe, "Habit-Formation," p. 87.

° Cf. Bagley's "Educative Process," pp. 122-3, 241-2, 243.

Suppose the instructor desires to give his class practice in "tongue grafting." (Exercise No.4 , p.86.) He should first demonstrate to his class how to make a tongue graft, by calling attention to the common diameter of cion and stock at the point of contact, the way to cut the notches, how to fit together the cut surfaces, and how to wrap the binding material. Then each pupil should be allowed to make several specimens of this graft, each of which should be submitted to the instructor for criticism. The exercise should be continued until the pupils have mastered the art of tongue grafting.

A series of laboratory exercises arranged in accordance with the principles previously set forth around which the recitation, the lecture, and the reading should center would form an effective course in secondary agriculture. Such a series of experiments should have to be made up largely of carefully selected types.⁺ These type exercises would furnish the means of forming habits that the stimuli of farm life would tend to set into operation. The types should have an element of commonness with the future conditions that the pupil will likely meet. This common element in the situation of the farm life and the past school training will suggest the use of certain school habits previously learned; hence the use of types for developing skill. It is the element of commonness that gives the cue, and forms a sort of apperceptive basis for the functioning of habit. There is at present great need for such a systematized series of exercises for the laboratory and field work of secondary agriculture.

⁺ De Garmo, Charles: "Principles of Secondary Education," Vol. II., p.71. Macmillan, New York, 1908.

In the fall of 1909, a questionnaire was sent out with this question: "What principles of agriculture do you suggest each class of students should work out in the high school laboratory?" These were sent to both college and secondary school men who have had experience in teaching agriculture. Following is the summary of the eighty-six answers received.

Total number of subjects given,	- - - - -	-229
Number of subjects in general plant studies,	- - - - -	73
" " " seeds, fruits, and grains,	- - - - -	24
" " " animal studies,	- - - - -	37
" " " soil studies,	- - - - -	62
" " " general farm management,	- - - - -	33
Number of subjects given once,	- - - - -	137
" " " twice,	- - - - -	38
" " " three times,	- - - - -	13
" " " four times,	- - - - -	8
" " " five times,	- - - - -	7
" " " six times,	- - - - -	9
" " " seven times,	- - - - -	5
" " " eight times,	- - - - -	1
" " " nine times,	- - - - -	2

"Principles of Selecting Seed," and "Testing Seeds for Food Materials," were each given eleven times; "Grafting," and "Milk Testing," thirteen times; "Seed Germination Tests," "Principles of Feeding," and "Soil Physics," fifteen times; "Grain Judging," sixteen times; and "Stock Judging," twenty-two times. Some questionnaires instead of giving subjects for laboratory exercises

simply referred to the exercises given in some text-book of agriculture. The number of these was twelve.

This summary shows that there is little agreement among school men as to what principles of agriculture should be taught by means of exercises in the laboratory of the secondary school. It also shows that some selection of type experiments should be agreed upon.

2. Notes of Exercises.

Pupils should be required to write up in permanent form the notes of all experiments and verifications, and as many of the demonstrations, and practice exercises as the teacher may judge proper. There are several reasons for this: it affords an excellent training in expressing definitely and with exactness ideas that relate to science and physical phenomena; a much needed training is afforded in recording, interpreting, and using scientific data; by means of these written statements of the pupil the teacher is the better enabled to ascertain whether or not the facts and principles have been learned; and the data, conclusions, answers, etc., are available for future reference. It is quite desirable to have a certain form that is adaptable to all the four classes of exercises, and the pupil should be required to adhere to it. If this is done, the work of both teacher and pupil will be greatly facilitated: the pupil in always having an outline to guide him and to suggest the necessary things to write about, and the teacher in having an orderly arranged and fixed plan to follow in his criticism. The pupil will also tend to acquire the habit of preparing manuscripts according to some plan, and of being neat and careful

with his written work. The following form has been worked out and used with success by the writer in connection with high school classes in agriculture.

Exercise No. ____.

Date.

The Subject of the Exercise.

=====

I. Performance.-- Under this head the pupil should present a full, exact, and plain statement of how the exercise was performed, giving the names of all pieces of apparatus used and how they were set up, the names of the different materials used and the quantity of each, the proper sequence of the various steps of procedure, and an exact description of each operation. These are the essential conditions of any exercise, and upon their relation depends its success. The pupil should recite these essentials with faithful regard to facts.

II. Results.-- A statement of the results of the exercise should be given under this head. If possible, all data should appear in tabulated form, in order to be in the most available form, and to give the appearance of neatness. The results should be formal and exact, for they are the bare facts of the exercise,-- the bases from which principles may be drawn or laws established.

III. Conclusions.-- The pupil should here state any principle or law which he has been able to induce from the results as interpreted in the light of the performance of the exercise. This is the vital aim of the exercise, and it should be concisely stated free from all ambiguity. This portion of the exercise will serve to develop his reasoning power and strengthen his judgment. To

prove that he clearly understands the relation between his data and his conclusions, the pupil should clearly and carefully state his reasons for making each conclusion. Otherwise, his assumption of knowledge may be challenged.

IV. Answers.-- After laws and principles have been induced and stated, comes the test of the pupil's intelligent understanding. This may readily be done by means of a few direct and well selected questions that go to the very heart of the exercise. The answers to the questions should be given under a separate head, and should be concise, plain, and definite. They should themselves suggest the question they are intended to answer.

V. Problems.-- Next after the pupil has gained knowledge, comes the development of ability to apply it. This may be accomplished by including a practical problem in the exercise,-- not necessarily a mathematical one. This portion of the exercise offers an opportunity for originality, and provides for connecting theoretical knowledge with the practical affairs of life. If the problem happens to be mathematical in its nature, a neat solution of it should be presented.

VI. References.-- It is often desirable to have the pupil read certain references on the subject of an exercise either before or after its performance, according to the nature of the exercise. If read before the exercise is undertaken, references often aid in the guidance of the pupil; this is frequently true in connection with practice exercises; if they are read after an exercise is finished, pupils are lead to view the facts, principles, or laws from another's point of view; this tends to broaden the pupil's

vision, and to strengthen his confidence in his own knowledge by finding it corroborated by the knowledge of others. The pupil should make a statement of the references that he has looked up and read on the subject of the exercise, and give an abstract of their contents.

The following directions should be carefully observed in the preparation of the manuscript of notes on the exercises . The permanent notes and drawings should be made in ink since they represent the pupil's final knowledge on the subject and are to be kept for future reference. The drawings should represent types; this will necessitate the observation of many specimens of the object, and the idea gained from a type drawing will be more correct than might result from the drawing of a single specimen. The directions for performing an exercise are usually given with the verbs in the imperative mode and the pronouns in the second person. Pupils are apt to imitate this; care should be taken to have them express the record of their own work with verbs in the indicative mode and the pronouns ^{in the first person and} either in the singular or plural number as the case may be. The three fundamental characteristics that the finished manuscript should conspicuously show are: neatness, exactness, and good English. Before submitting his manuscript to the instructor for criticism or approval, the pupil should carefully read it thru in order to discover and correct any previously undiscovered errors.

Some difficulty will likely at first be experienced in the effort to get the pupils to adhere to the form presented, and to

successfully follow all the directions. To reduce this difficulty to the minimum, the first notes should be written under the immediate direction and supervision of the instructor, until some degree of proficiency is acquired. When the form becomes an habitual one, it will greatly facilitate the making of laboratory and field notes on the part of the pupil, and the instructor will find his work of examining them much reduced. From the very beginning, the instructor should insist that each item called for in the exercise be fully developed. In case any section needs to be omitted, the remaining sections should retain their usual number. For example, if the section headed "IV. Answers" were omitted, "Problems" should be numbered "V." as the section "IV." were not missing. This will facilitate the matter of referring to the various parts of the manuscript.

Pupils, who have been under close supervision while working out an exercise, and who have developed right habits of expression and of adherence to the proper form and to the instructions for developing the notes, may be permitted to write out their permanent notes at other hours besides those usually spent in the laboratory. Carbon copies of the original data may be made in the laboratory and left with the instructor, and thus comparisons may be made with the permanent notes if the teacher desires to do so.

3. Directing the Laboratory and Field Work.

In regard to the performance of the exercise, the pupil should follow with careful exactness and minute detail the instructions which he receives for making manipulations, observations, and records. What may seem a very insignificant matter in the

performance may greatly affect the final results of the exercise. The pupil should have some previous knowledge of what is expected of him in performing the exercise and to this end the directions should be carefully studied before entering the laboratory. With beginners, it is often advisable for the instructor to perform a part or even the whole of an exercise before the class and then allow the members of the class to perform it. Suppose seeds are to be tested for starch. The instructor may well first apply the test to corn starch. This will show the pupils how to proceed and will also acquaint them with the reaction that will occur if starch is present. (See Exercise No. 5 , p. 88.) By this means much time will be saved and many accidents avoided. It is also often advisable to give beginners oral direction. This will keep the entire class together, and those who lack initiative will be greatly helped. The exercise may often be introduced by a short talk by the teacher on the purpose of the exercise, the reasons for the method of procedure, the related facts which are or should be known, and the possible sources of error. After some facility in laboratory methods has been gained the pupil should be given the printed directions and the oral introductions may be reduced in frequency. The class should have close supervision while at work in the laboratory.

In the performance of the exercises, it is always desirable to secure individual work. It is in this way that independence in original investigation is developed. When more than one are working at the same exercise it may be depended upon that not all are being equally benefited, nor is each securing the fullest experience or knowledge which it would be possible for him to receive

were he working alone. The apparatus needed for the laboratory work of secondary agriculture is, for the most part, quite inexpensive, and every effort should be made to supply enough pieces so that individual work may be had. If this is not possible, not more than two pupils should be permitted to work together. There are some exercises when a combination of two members may result in good work.

The work of the laboratory and of the field or garden offers excellent opportunities for inculcating habits of order, system, and primness, which are qualities so desirable in every home, school, farm, and business house. At the beginning of the exercise the pupils should find their own apparatus, tools, and materials, which they are to use. At the end of the laboratory or field period, the apparatus and tools should be cleaned and carefully placed in their assigned places, materials stored away in accordance with requirements and all rubbish disposed of. The place where the exercise was performed should present as good an appearance after the work is finished as before it began.

"Since agriculture deals with gross and variable materials the laboratory work in agriculture may easily be more technical and exact than the occasion warrants." ^x The teacher should remember that the purpose of the laboratory exercises is to teach knowledge to the pupil, which the former already knows. The pupil is not a pioneer investigator along the frontiers of human knowledge, even when he performs an experiment; neither has he mastered the

^x Main, Josiah: "A Manual for High Schools," p. 9. University of Tennessee, Knoxville, 1909.

field of knowledge whereof some certain principle is a part, which he is now set to discover by means of an experiment. There is a vast difference between the original investigator and the average high school pupil. The latter, may at times, be the former in the making, but at best it will only be in imitation and at infrequent intervals. The "scientific method" is not learned in a few years by immature adolescents; the scientific method is the highly developed product of very mature minds. Most high school pupils will do well, if they learn the beginnings of that method, yet toward the end of the science course, even in secondary agriculture, a somewhat worthy beginning should be in evidence. Right instruction in agriculture in the high school will do much to develop a tendency and habit in scientific methods of thought and investigation among the masses. Elemental scientific principles of agriculture, and ~~of~~ fundamental scientific methods of investigation may be diffused together. The two may thus go hand in hand, and neither will be sacrificed to the other. Indeed, if scientific method is seen by the pupil to solve vital and practical problems, as is ever possible in the proper teaching of secondary agriculture, the sanction which it will receive from the pupil will make its transference to other fields far more probable than if it is confined to the problems of pure science.

4. Time for Laboratory and Field Work.

If the class in agriculture recites four or five times a week, and the recitation periods are forty to forty-five minutes in length, it is not advisable to have ^{more} than two double periods a week especially devoted to laboratory work. These periods should come

on the first and the last days of the school week so that growing crops, germination tests, etc. may receive proper attention without too great delay. But it should not be inferred that laboratory or field exercises should be limited to the days of the week that have the double periods. Such a mistake would prove most serious. The teacher should be free to conduct ^{laboratory} exercises on other days, and, if occasion warrants, to use the double period ~~period~~ for a test, for a recitation, or for hearing reports from assigned readings or home experiments by various members of the class.

Many laboratory and field exercises are capable of being completed within an ordinary recitation period of forty minutes. On the other hand there are numerous exercises in secondary agriculture that may be prepared within a few minutes, but that must continue for several days in succession before they reach completion. Several such exercises may be started at a single period and stated observations made thruout the following days by all the members of the class. Pupils should be encouraged to make experiments and tests at home, and such work may be occasionally assigned to individual members, and reports called for in due time.

CHAPTER VII.
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AN ILLUSTRATIVE CLASSIFICATION OF LABORATORY EXERCISES.
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The list of laboratory exercises on the following pages is not supposed to present a complete classified list of type exercises as a basis for a course in secondary agriculture. The purpose is to set forth a plan illustrative of the principles of this thesis, and to suggest how a course might be worked out in accordance with them.

It will readily be seen that the exercises are interchangeable; i.e., an experiment or verification may be made a demonstration and vice versa; or a demonstration may be made an exercise for practice work or vice versa. The class into which any exercise may be placed will depend upon the purpose to which it is put. It might be desirable, for example, to give the pupils practice in the manipulation of apparatus, and training in systematic methods of procedure in laboratory work. Such an exercise as No. 6 on page 88 may well be used as a practice exercise for securing the desired training, instead of using it as an experiment. The classifications of exercises as given hereafter are merely suggestive.

1. Exercises in Plant Studies.

Exercise No. 1.

Demonstration.

Seeds Contain Moisture.

=====

Place separately dry seeds from six different plants into as many test tubes, filling the tubes about one-third, and cork lightly. The preceding should be done before the class assembles. Show the seeds to the members of the class so that they may know them to be dry. Hold each tube in succession over a flame several minutes, until moisture collects on the sides of the tube.

In the meantime explain the precipitation of moisture, and ask the following questions: Will a perfectly dry substance freeze? Will water when mixed with dust, flour, and so forth, freeze? What makes mud freeze? Where does the moisture that collects on the side of the tube come from? How do you know it does? Did the seeds seem perfectly dry at the beginning of this exercise? What relation does moisture in grain have to the danger of its freezing? Should grain, which is intended for seed, be exposed to the cold? Why?

Form conclusions respecting the moisture contained in seed and its relation to the storing of seed. Express these conclusions in good English sentences and record them.

Exercise No. 2.

Verification.

The Function of the Potato Peel.

=====

Carefully weigh a potato; then pare another larger one, and cut portions from it until its weight is made equal to that of the first one. Set them away in some safe, warm place where they will

be freely exposed to the air. After three to five days reweigh them.

Which potato weighs the more? Why? What does the result show in regard to the use of the skin? What relation does the fact learned from this exercise have to the digging, handling, and storing of potatoes? Write up this exercise according to the form and directions given you.

Exercise No. 3.

Practice.

Judging Ears of Corn.

=====

Bring to the laboratory ten ears of corn that you consider first class for use as seed. Number all the ears consecutively by sticking a long pin thru a numbered tag into the but end of each cob. This much should be done at least one day in advance.

As a preparation for the practice exercise proper, read two or more of the following references: (1) Farmers' Bulletin No. 229, pp. 8-11;* (2) "Ten Lessons on the Study of Indian Corn," pp. 9-16;^o (3) The Agricultural College Extension Bulletin, September, 1906, pp. 4-7;⁺ (4) "An Elementary Laboratory Study in Crops," Bulletin No. 26, 1907, pp. 22-27;^x (5) Jackson and Daugherty's "Agriculture through the Laboratory and School Garden," pp. 246-9; (6) Nolan's "One Hundred Lessons in Agriculture," pp. 34-47.⁼

* Address: Department of Agriculture, Washington, D. C. (Free)

^o Address: College of Agriculture, University of Missouri, Columbia, Mo. (Free)

⁺ Address: Extension Department, College of Agriculture, Ohio State University, Columbus, Ohio. (Free)

^x Address: State Department of Public Instruction, Lansing, Mich. (Free)

⁼ Acme Publishing Co., Morgantown, W. Va.

Score card for corn.

Points.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Trueness to type.....	10									
2. Shape of ear.....	10									
3. Purity of color in grain and cob.....	5			9						
4. Vitality, maturity, germinating power.....	20									
5. Tips of ears.....	5									
6. Butts of ears.....	5									
7. Uniformity of kernels.....	5									
8. Shape of kernels.....	5									
9. Length of ear.....	5									
10. Circumference of ear.....	5									
11. Furrows between rows.....	5									
12. Space between kernels at cob.....	10									
13. Proportion of corn to cob.....	10									
Total.....	100									

Make a score card like the one shown above, providing one column for each ear of corn. The figures in the score card just to the left of the first perpendicular line show the number of points that should be given for a perfect ear, e.g., if you think that ear number 4 is nearly perfect in shape you would probably mark nine in line 2, column 4, as shown in the table. Examine carefully each ear of corn and put down on your score card in the column of the same number as the ear of corn your estimate of the qualities named at the left of each line, except line 4--Vitality-- which should not be filled in until after the seed is tested in a later exercise.

When should seed corn be selected? Why? Compare the ear that received the highest number of points from all the members of the class with the ear that received the lowest number. Which kind of corn is the more economical and profitable kind to grow? Why?

Exercise No. 4.

Practice.

Tongue Grafting.
=====

References: Farmers' Bulletin No. 157, pp. 18-9; Burkett's "Agriculture for Beginners," pp. 83-4; Bailey's "The Nursery-Book," pp. 108-11. Study any two of these.

The graft is made by cutting the stock off diagonally-- one long smooth cut with a sharp knife, leaving about three-fourths of an inch of cut surface, as shown in the figure, a. Place the knife about one-third of the distance from the end of the cut surface, at right angles to the cut, and split the stock in the direction of its long axis. Cut the lower end of the scion in like manner, b; when the two parts are forced together, as shown at c, the cut surfaces should fit neatly together so that one will quite cover the other. It is essential that the cambium layers of stock and cion meet. Why? To secure this requirement, the stock and the cion should be nearly the same diameter at the point of contact so as to fit together nicely. After the cion and stock have been locked together as shown at c, they should be wrapped with five or six turns of waxed knitting cotton to hold the parts firmly together. Make several such grafts and hand each to the instructor as soon as it is completed. He will point out its defects for you, which you may remedy in your next attempt.



—Whip grafting: a, the stock; b, the scion; c, stock and scion united.

What is the purpose of grafting? Name the different parts of a graft. Why is this particular kind of graft called "tongue graft"? What other name is sometimes given to it?

The instructor should make at least one tongue graft before the class, being careful that all may clearly see him do it. He should explain all essential operations, and the reasons for them.

When the pupil hands him a finished graft, it should be carefully examined, taken apart, and the defects criticised and the good points approved.

Exercise No. 5.

Demonstration.

How to Test for Starch.

=====

Stir a pinch of starch into a little water previously heated in a test tube. By means of a pipette, place a drop of iodine solution into the starch water, and stir it. There will appear a blue color in the tube. This is the test for starch, the intensity of the color varying with the amount of starch present. The pupils should attentively observe the teacher while he is making this test. Pass the test tube to the various members of the class for closer examination.

Exercise No. 6.

Experiment.

Testing Grain for Starch.

=====

Bring about a gill of the following grains to the laboratory: corn, wheat, oats, rye, buckwheat, beans, peas, and rice. Grind or crush these seeds, and treat the meal thus formed as your instructor treated the starch in the preceding exercise.

Tabulate your data in the following form:

Grain	Starch	Grain	Starch
Corn		Buckwheat	
Wheat		Beans	
Oats		Peas	
Rye		Rice	

Write "much", "some", or "none", according to the reaction, in the proper spaces.

From which grains would it be most profitable to manufacture

starch? Read on the process of manufacturing starch in an encyclopaedia. From what source is our starch mostly derived? What are some of the uses of starch?

2. Exercises in Soil Studies.

Exercise No. 7.

Experiment.

The Effect of Mulch on Soil Moisture.

=====

Fill to within an inch of the top three gallon battery jars, or three gallon milk crocks, with equal amounts of loam by weight. (All the vessels must be uniform in size and shape.) Thoroly moisten the soil in each vessel by pouring into each the same amount of water. Record the weights of the moistened soil. Set the jars away together, allowing the soil in one to remain undisturbed, firming the soil in another, and so soon as the soil in the remaining jar will permit, thoroly cultivate its surface with a course toothed comb to the depth of about an inch. Thoroly cultivate the surface of the soil in the last jar every day. Weigh the jars each succeeding day for a period of one week. Tabulate the various weights in a neat form.

Which soil looses its moisture most rapidly? least rapidly? How was the moisture lost? Did capillarity aid in bringing about this loss? How? Why was the soil in one jar left untouched? What conditions might cause an error in the results of this experiment? Were there any such conditions present in this experiment, and what were they? (If any serious condition of error was present, the experiment must be performed again, care being taken to eliminate the source of error referred to.) By what principle does a mulch of

soil conserve the moisture? Should a crop^{be} cultivated during a drouth? Why? What is the effect of cultivating the soil as soon as it is in proper condition after a heavy rain? What would be the effect upon the soil moisture if the field is not cultivated after a heavy rain? What is one principle of cultivation as demonstrated by this exercise?

Read what you can find on "mulch" in the agricultural books and bulletins in the library.

It will be readily seen from the foregoing illustrative list of exercises that a complete course in secondary agriculture might be organized, using laboratory and field exercises as the basis for the various topics to be studied.

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